SUSTAINABLE DEVELOPMENT IN ABBOTTABAD DISTRICT:

AGRICULTURE:

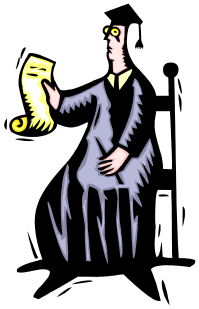
HORTICULTURE:

PLANT NUTRITION:

ON-FARM SOIL & WATER CONSERVATION:

HEBBS, SPICES & ESSENTIAL OIL PLANTS:

A WAY AHEAD:



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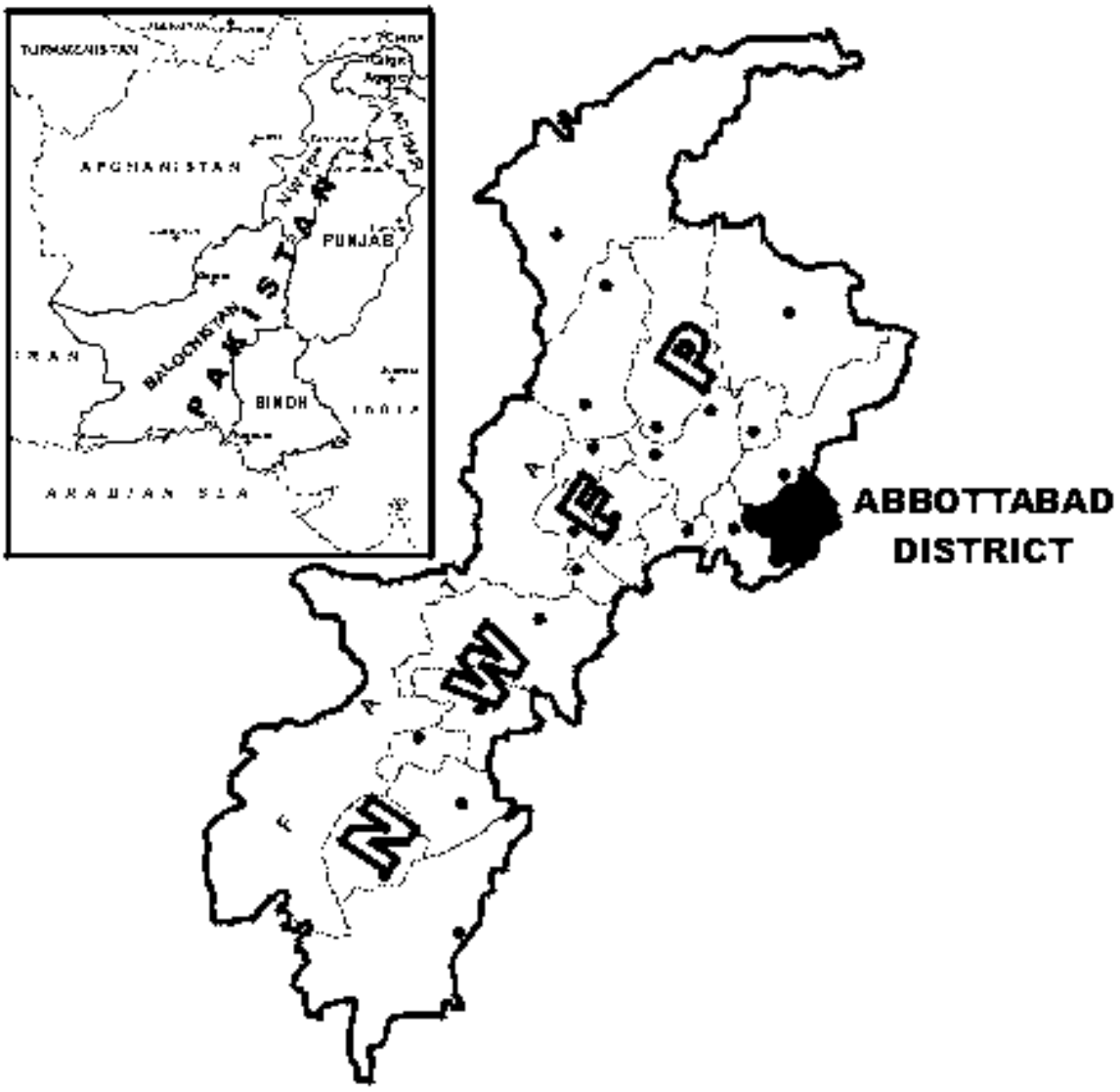


Figure 2: Map of NWFP (Hazara).

EXECUTIVE SUMMARY:

1. The paper covers the related subjects of Agriculture, Horticulture, Plant Nutrition, On-Farm Soil and Water Conservation and Herbs, Spices, Condiments and Essential Oil/ Aromatic Plants. It discloses the fact that there is plenty of room for improvement both vertically as well as horizontally. The present fertilizer regime that is in use is not only wasteful it is also insufficient to meet the demands of the crop as well as causes actual physical harm to the environment. Subsistence agriculture, as is presently being practiced, can be replaced with Rational Agriculture. This type of Agriculture provides Integrated Crop Management as a tool for greater yields and added returns. At the same time it ensures that there is no harmful fall out that adversely affects the environment. Sustainable Agriculture and its related fields of water and soil conservation form the first two of the fourteen core areas of the National Conservation Strategy. The objectives of the Sarhad Provincial Conservation Strategy are covered in the first two and the final 7th objective. Thus the importance of this subject cannot be over emphasized.

2. All related data from authentic sources, duly acknowledged, have been provided as to the present situation on ground. This has been examined in relation to the latest GIS information about the District. It has been found that there is a rather alarming situation on ground vis-a-vis Agriculture, Forests and Rangelands. These need to be seen to immediately and effective measures should be taken before it is too late. Development Constraints and Remedial measures have been outlined. New approaches and possible high value plants have been pointed out. It is now necessary to examine the Way ahead in a systematic manner. Agriculture and Horticulture are closely linked with other Sectors of Development. It is not possible to come up with a development strategy that deals exclusively with these subjects. The overall context of Sustainable Development needs to be kept in mind.

3. A brief for possible short, medium and long-term measures is provided for examination. These are further marked as high priority measures to ensure sustainability.

3.1 Short-Term Measures:

i. High Priority Measures:

a). Construction of Low Cost “Buns” and other water reservoirs for water harvesting.

b). Introduction of Low Cost Sub-soil (reticulation) Drip and Sprinkler irrigation.

c). Establishment of EM (Effective Microbial) Technology, Quick turn over Compost beds for:

- aa). Buffering soil and plants against alkalinity/ acidity and ill effects of unstabalized and unsafe chemical fertilizers.
- bb). Making soils more friable.
- cc). Retaining moisture.
- dd). Providing earthworms and other beneficial microorganisms with suitable environment and nutrition.
- ee). Providing nutrition to plants.
- ff). Growing produce for specialized Organic Markets.

d). Seed inoculation with Rhizobium Bacteria.

e). Short-term Capacity building measures for farmers.

f). Establishment of Low Cost, Environment Protected, Organic Bed, Sub-soil (reticulation) and Misting Irrigated "Wah Gardens" and Permanent, Pakistani, Sunken, Organic Beds with Semi-Hydroponics, Sub-soil (reticulation) Irrigation (Environment control through Mini-Tunnels).

g). Institution of Rational and Sustainable Agriculture Fund: This fund would provide quality inputs to the farmers on Community basis. The loan return record of the organized communities in the District is 100 % (SRSC). This fact coupled with peer pressure that penalizes the entire community for non-performance of individuals will ensure success. It is only possible to extract the maximum benefits from the soil when quality inputs are available at the right time and at the right place.

ii. Routine Measures:

a). Manufacture of safe and stabilized mineral fertilizers including NPK formulations and covering complete range of Major, Secondary and Micro Nutrients.

b). Community based growing and marketing: Organized communities can plan and execute short and long term planting plans once they have the support of assured markets. Not every individual is capable of effective marketing. Those who have these skills can perform wonders for those who do not.

c). Export Market: It is necessary to tap the export market for high value produce. This factor can ensure sustainability of the efforts. Facilities need to be established and avenues for export need to be explored.

d). Establishment of soil and water testing laboratories.

e). Establishment of Green Sector Development Authority for coordination and control that ensures Sustainable Development.

f). Complete coverage of Rural Areas by the Clusters of Community Based Organizations.

3.2 Medium Term:

i. High Priority:

a). Sustainable re-plantation of water sheds with companion planting to ensure success and provide for harvesting of firewood, edible oil, fodder, light building material, nitrogen fixation and quick establishment, e.g. Pine and Sea Buck Thorn.

b). Soil conservation measures through Biological agents (Elephant grass etc.).

c). Streams and Nullah Beds improvement and protection from pollution.

d). Use of Jack pumps with alternate means of energy if possible.

e). Crop Insurance through Associations and CBOs.

ii. Routine Measures:

a). Further Capacity Development: Many of our farmers are unaware of the possibilities inherent in the soil. There is great need to take on the task of educating them on a medium term basis by conducting hands on training. Seeing is believing may be a well-worn cliché but it is never the less very true. The difference between a 40-maund wheat produce per acre and 20 maunds per acre is very much apparent. The preferred method of this is to establish Service Centers in the Major Agriculture Extension Circles and present the farmers with viable alternates. This can be done through Intensive

Diploma Courses that include but are not restricted to: Green House Operations; Nursery Operations; Horticulture; Apiculture; Floriculture; Silviculture; Sericulture; Aquaculture; Mushroom Cultivation; Plant Nutrition and Safe Pesticide Use.

b). Detailed analysis and data banks that act as knowledge base should be prepared and made available to the public in the National Language. This is possible through Urdu Web Sites and Interactive CDs. True all the people are not in a position to purchase Computer Equipment. However, where they are available they can be made use of. Training material that is dynamic and easily digestible should be prepared and disseminated to the Communities.

c). Existent facilities like the Potato Research Center should be brought under the control of the District and maximum benefit should be taken. There is a potential of producing up to two hundred thousand bags of seed potato per year. This is being grossly under utilized at present.

d). Establishment of EM Technology and Rhizobium Culture in modern and fully equipped laboratories for provision to the public.

3.3 Long Term:

i. High Priority:

a). Provision of support to and strengthening of SRSC Network through existing 5 Agricultural Officers of their respective Agricultural Circles (Sherwan; Havellian; Nathiagalli; Abbottabad and Lora) and 1 Community Center (Pattan Khurd).

b). Provision of support to and strengthening of Agricultural Officers through facilities like motorcycles and telephones. Detailed training and capacity building of their staff including the AOs.

ii. Routine Measures:

a). Creation of HillSide Farming Institute in the presently under utilized Bara Galli Campus of the Peshawar University. This Institute would provide under graduate and postgraduate education in HillSide Farming. The Institute could also carry out Basic, Adaptive and Applied Research & Development in the fields of Agriculture and Horticulture that is specifically adapted to hilly terrain.

b). Association with Commercial Companies to Community Based Growing for their export and domestic requirements. A Commercial company is already operating in the field and exporting 1 ton per week of Iceberg Lettuce at Rs. 60.00 per Kg. This can be done through local communities.

4. In short there are a few very important steps that can be undertaken with the minimum of investment. The proposal for Green Sector Development Authority as put forward by Dr. Meera Khan needs to be examined and developed further. The most pressing problem is that of water conservation. This can be achieved through water harvesting and drip irrigation. The package presently available with NRCP needs to be put to use in conjunction with modern nutrients and certified seed and planting stock. This, in a nutshell, is the agenda for positive change. Field tests have proved the efficacy of establishing Technology Receiving & Transferring Centers along the lines of the Comilla Approach of the late, lamented Akhter Hameed Khan. Aridity, drought and desertification are the ultimate fate of areas that are treated as ruthlessly as ours have been. The recent example of Afghanistan lies just next door. Do we await just such a fate or do we initiate timely conservation and corrective measures?

CHAPTER 1:ABBOTTABAD DISTRICT:

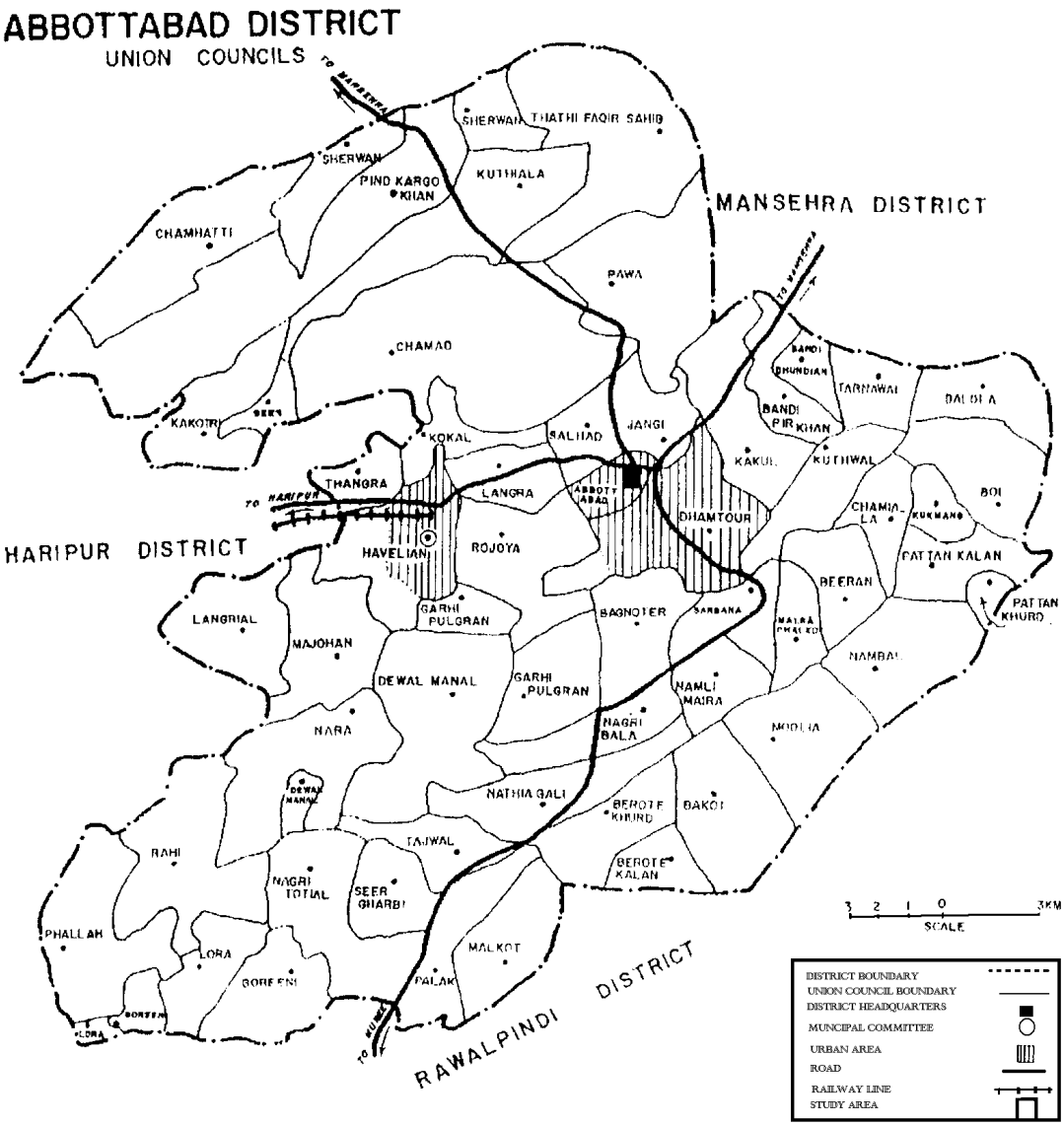
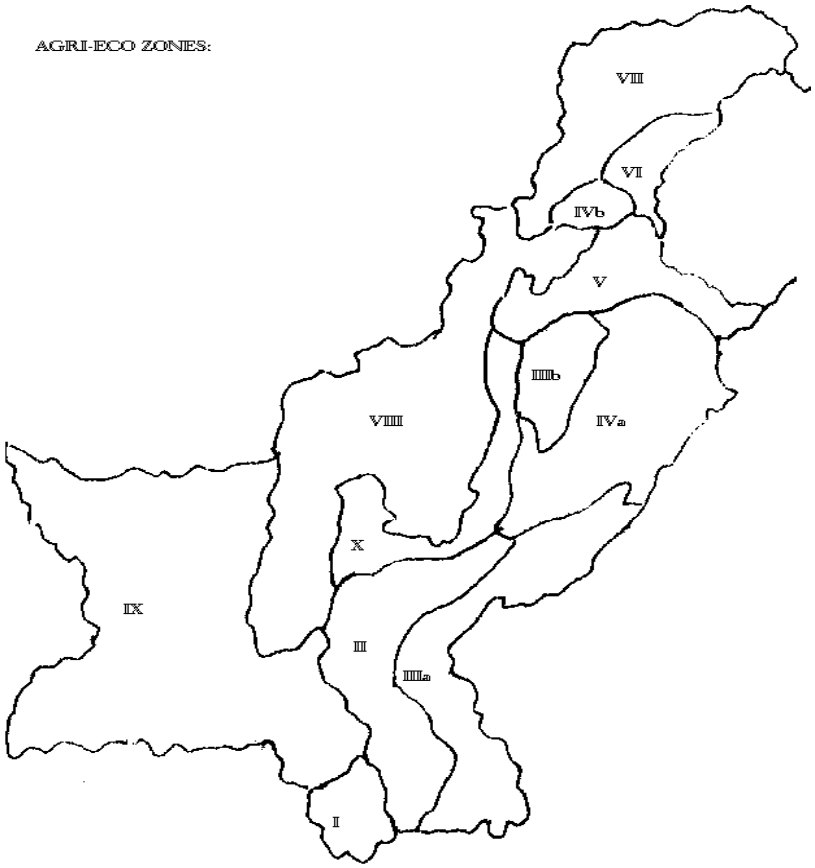


Figure 1: Map of Abbottabad District[1].

[1] Abbottabad District Census Report, 1998.



I = Indus Delta. II = Southern Irrigated Plain III = Sandy Desert (a & b)
IV = Northern Irrigated Plains (a & b) V = Barani Lands VI = Wet Mountains
VII = Northern Dry Mountains VIII = Western dry Mountains IX = Dry Western Plateau
X = Sulaiman Piedmont

Figure 2: Map of Pakistan Agri-Ecological Zones[1].

1. CLIMATE:

Abbottabad District falls within the Wet Mountains Agri Eco Zone, or Zone VI shown in the map. The average annual rainfall in the Abbottabad District is 2673 mm and the climatic division, based upon the classification by Ahmad, (1951) is the sub-humid division of the subtropical continental highlands. This is characterized by rainfall from both monsoon (July to September) and western disturbances (December to April), giving a twin peak type distribution with the maximum precipitation occurring in July to September. October and November are the driest months with less than 30 mm rainfall. The Galliyat area of Abbottabad District receives about 89 rainy days a year, or one fourth of the year. The Murree – Gallies Mountain areas are the wettest mountains in Pakistan. The summers of the District are pleasantly cool (20 – 26 C) while winters are severe with considerable frost and small quantities of snow in the month of January. Humidity in July and August is greater than 70 %. It ranges between 40 to 70 % during the rest of the year, at no time does the humidity fall below 40 %. Thus there is no great stress upon humans or plants. Relative humidity below 40 % causes parching of human skin, and

[1] Regional Soil Survey Report, Rawalpindi Area, Soil Survey of Pakistan.

plant's foliage due to increased evapo-transpiration. Thus the yearly mean humidity of Abbottabad District is 60 %.

Table 1: Average Climatic Data for 30 Years (1961 – 1990). Kakul Station. [1]

Parameters	Months												Total
Mean Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Min. Temp. (C)	-1.8	-1.6	1.9	6.9	10	14.2	16.2	15.8	12.5	7.8	3.5	-0.2	7.0
Mean Temp. (C)	7.2	8.1	12.4	17.3	21.8	26.1	24.8	23.8	22.3	18.4	13.6	9.2	17.1
Daily Range (C)	10.8	10.5	10.8	11.9	12.8	12.7	9.5	8.8	11	12.9	12.9	11.5	11.4
Rel. Humidity (%)	53.6	64	61.3	56.6	47.3	46.6	71.3	78.6	67.3	56	52.6	58.3	60
Wind Speed (kts)	1.2	1.4	1.7	1.6	1.7	1.8	1.3	1.3	1.4	1.5	1.3	1.1	1.4
Precipitation (mm)	69.7	227.6	284.6	223.6	163.3	170.6	516.6	522.6	193.8	113.8	63.8	123	2672.9

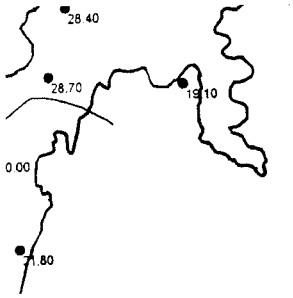


Figure 3: Mean Summer Daily Temperature.

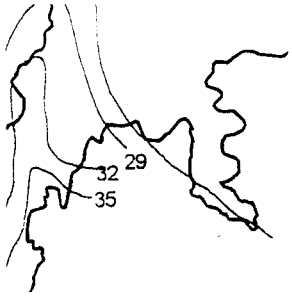
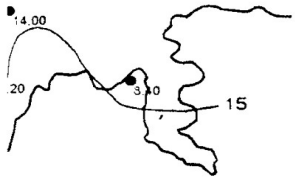
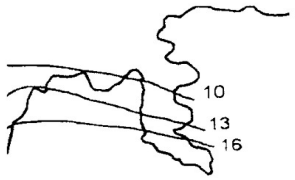


Figure 4: Mean monthly Temperature July.

Figure 5: Mean Winter Daily Temperature.

Figure 6: Mean Monthly Temperature January.





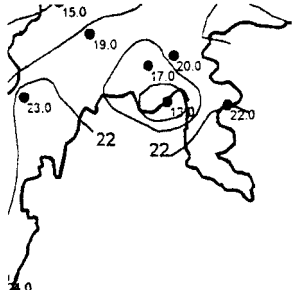


Figure 7: Mean Annual Temperature.

[1] State of Environment and Development in the HKH Region of Pakistan, Prof. Dr. Amir Khan, ICIMOD, 2000 (Including Figures 5 to 16).

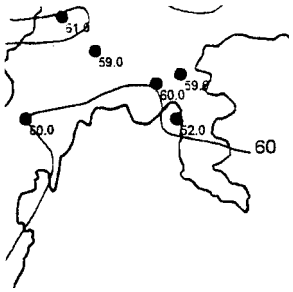
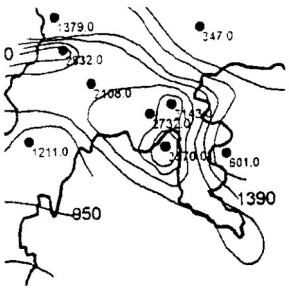
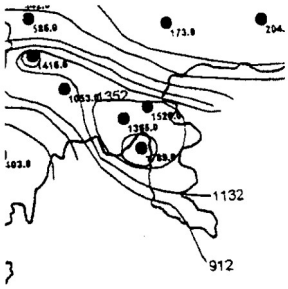


Figure 8: Mean Annual Relative Humidity.





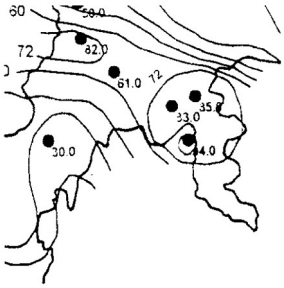
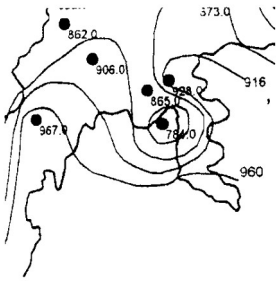


Figure 9:Annual Precipitation (mm) Figure 10: Annual Norms Precipitation.

Figure 11: Normals of Mean Rainy Days.



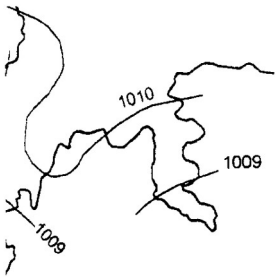


Figure 12:Annual Air Pressure. Figure 13: Pressure January. Figure 14: Pressure July. Millibars.

2. GEOLOGY:[1]

The Abbottabad District lies within the Indo-Gangetic synclinorium (geo-syncline). It has a complex geological history of mountain building, alluvial and loessic depositions and erosional cycles. Inter-bedded conglomerates, sand-stones, shales and silt-stones mainly underlie the area. It was subjected to folding and faulting during the Pliocene and early Pleistocene eras. The

[1] Wadia – 1966.

periods of uplift and deformation alternated with periods when erosion was dominant. Later in the Pleistocene, a mantle of silt, locally mixed with water-laid sand and gravel, was deposited in the irregular troughs that had been carved out in the rocks of the Murree and Siwalik series. The wind-laid silty material is generally of very uniform texture.

The Western most parts of the Himalayas lie within Pakistan to the East of the Indus River. Hazara Division falls within this area and a number of East-West Ranges are to be found. The Sub-Himalayas or 'Siwaliks' are the Southern most Range. This Range does not rise to the heights of the Main Himalays as peaks range from 600 to 1,200 metres (2,000 to 4,000 feet). The rocks within this Range are folded, faulted and deeply gullied by the action of streams. The Lesser Himalayas lie to the North of this Range. A part of this Range also falls within Abbottabad District. The peaks of this Range vary from 1,800 to 4,600 metres (6,000 to 15,000 feet). They too are folded, faulted and overthrust. An interesting Relief Feature lies within this area. The Lesser Himalayas comprise a series of ranges, which form a complex system of sharp bends and abrupt changes in orographic axis. These are described as arc, lobe, orocline, re-entrant, hair pin bend or syntaxis. The North West trending Pir Panjal Range are linked to the South-West trending Hazara Mountains through a sharp hairpin flexure. This has been variously termed as the North West Himalaya Syntaxis, the Hazara Syntaxis and the Abbottabad Syntaxis, among other names.[1]

Hazara Division lies within what is known as the Internal or Abbottabad Zone (hinterland), as opposed to the External or KalaChita Zone (foreland) of the Indian Plate, in what is essentially the result of Plate Tectonics. Scientific evidence has shown that three Plates, namely the Karakorum, the Kohistan and the Indian Plate collided during the Cretaceous and Early Tertiary Periods. The Indian Plate separated from the Gondwana Continent and drifted to collide at the Main Mantle Thrust (MMT) with the Kohistan Plate. This latter Plate had earlier collided with the Karakorum-Eurasian Plate. Thus the Kohistan Plate is sandwiched between the Karakorum and Indian Plates. The Hazara Mountains are comprised of Crystaline Rocks as opposed to the stratified sedimentary rocks of the Hill Ranges (Margala, KalaChita and Kohat) Kohat-Potwar Plateau and Salt Ranges. The Abbottabad Zone comprises unmetamorphosed fossiliferrous rocks of early Palaeozoic age which overlies a sequence of variable metamorphosed rocks of imprecisely defined Late Proterozoic age.

The District is partly bounded by the Siran River in the North-East and the Jhelum River in the East. The District is mainly drained by the Dor and Haro Rivers with many smaller tributaries know as "Khatthas". Unlike the rivers of the Punjab plains, these rivers are eroding material, not depositing it. The erosion is very active and has resulted in deep gullying.

Extensive deposits of gravel in the North-East are probably mainly outwashes from glaciers and streams in the lower Himalayas. Some conglomerates of greater age occur in the same area. Two distinct loess deposits have been identified. The lower one is denser and mottled, the upper more porous and of uniform color. The surface of the lower loess often has a buried soil with appreciable development. Present day soils have developed almost exclusively in the upper loess. The loesses are estimated to be of Middle and Late Pleistocene age respectively. In places thick sandy or stony piedmont deposits replace the mottled loess. Elsewhere the two loesses are separated by piedmont material and locally strips of stony piedmont material occur within the upper loess. In places the upper loess rests upon bedrock.

[1] State of Environment and Development in the HKH Region of Pakistan, Prof. Dr. Amir Khan, ICIMOD, 2000.

Figure 15: Geomorphology[1].

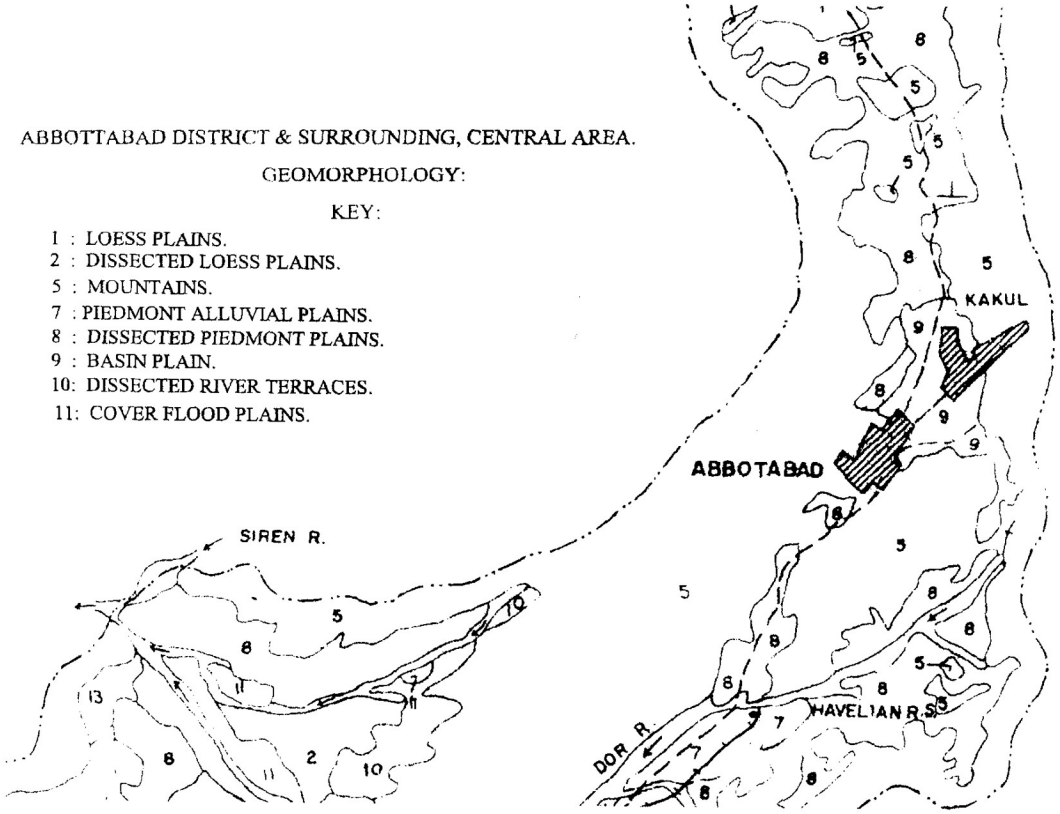
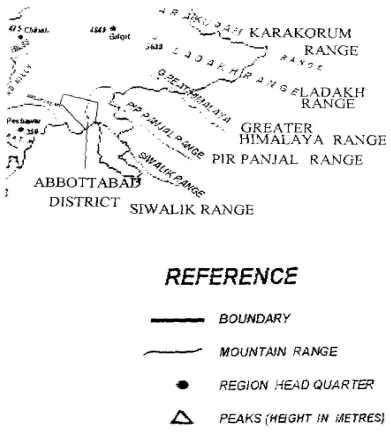


Figure 16: Mountain Ranges.[2]



[1] Regional Soil Survey Report, Rawalpindi Area, Soil Survey of Pakistan.
[2] State of Environment and Development in the HKH Region of Pakistan, Prof. Dr. Amir Khan, ICIMOD, 2000.

3. LANDFORMS:[3]

The loess plain (Rash Plain) consists of deep deposits of wind laid material (loess). These aeolian deposits are probably of Pleistocene age.
The surface of the plain is mainly level to nearly level or gently undulating. In view of the age of the deposits, any relief has to be attributed to erosion rather than to deposition. In most of the area, recognized as loess plain, there is no serious gully erosion. Soil texture in the landform is very uniform locally but ranges from silt loam to silty clay over greater distances. This unit is referred to as Basin Plain in the Colombo Plan Report.

4. SEDENTARY MATERIALS:

4.1 MOUNTAINS:

In the North-East and North-Western parts of the District, this landform comprises extensive areas where the bedrock is exposed and where mountains with only fragmentary and thin soil formation occur.

4.2 WEATHERED ROCK PLAINS:

This landform occurs where a residual soil cover has been able to develop on exposed rock surfaces. The residual material is usually mixed with materials transported by wind and water. The soils however, still reflect the nature of the parent rock. This unit is referred to as Weathered Bedrock Plain in the Colombo Plan Report.

4.3 RIDGE AND TROUGH UPLANDS:

In Pakistan, this landform occurs in the Potwar uplands. It is quite extensive in the District. It occurs where vertical or almost vertical beds of the Siwalik formation come to the surface. The Siwalik formation usually has alternating bands of sandstone and shale. Sandstone being somewhat more resistant to weathering, generally stands out as barren, long parallel ridges within the landform. The softer shales between these ridges have weathered to varying depths into reddish clay. Thickness of the weathered material increases from the edge to the center of the troughs. Along the edges, the surface also shows an influence of the weathering products of the sandstone. This unit is referred to as Ridge and Trough Uplands in the Colombo Plan Report.

MOUNTAIN OUTWASH DEPOSITS:

5.1 ALLUVIAL FANS:

Alluvial fans occur at the foot of the mountains where streams emerge and where the sudden decrease in velocity causes the deposition of coarser materials in streambeds. The Streams usually become clogged and are forced to seek other courses. Repeated change in course results in fan-like patterns of depositions in the form of cones, with the coarser material at the apex. Thin soil mantles are sometimes found on the gravelly material. This unit is refereed to as Alluvial Fan in the Colombo Report.

5.2 PIEDMONT ALLUVIAL PLAINS:

In the District, piedmont alluvial plains have formed in the lower coalescing parts of alluvial fans, where there is only an almost imperceptible slope. The soils of the piedmont alluvial plains are generally coarser on the higher parts and finer on the lower parts. There may also be a few depressions at the fringe of the piedmont, with fine textured profiles. This unit is

[3] Colombo Plan Report – 1958.

not recognized as such in the Colombo Plan Report but is included in either the Basin Plain or the Dissected Basin Plain landform.

5.3 DISSECTED PIEDMONT PLAINS.

This landform comprises old piedmont plains, severely gashed by torrent beds and tributary gully systems, occurring in the extreme Northern parts of the District. Much of this landform is not cultivable due to recent erosion but cultivation is attempted on the non-eroded remnants of the original surface and on the less steep sides of the gullies. This unit is not recognized in the Colombo Plan Report.

5.4 BASIN PLAIN:

A basin plain is a mountain-ringed plain, which has derived its deposits from the surrounding mountains. These materials are carried and deposited by torrents. The Rash Plain adjacent to Abbottabad City is such a plain and is also not included in the area covered by the Colombo Plan Report.

RIVER OUTWASH DEPOSITS:

6.1 COVER FLOOD PLAINS.

This landform occurs along the Haro and Dor Rivers. It consists of older parts of the river plains which are rarely flooded and in which the relief has been largely obliterated. The cover flood plains are generally separated from the active flood plains by a steep bluff, but locally the transition is gradual. This unit is referred to as such in the Colombo Plan Report.

6.2 ACTIVE FLOOD PLAINS.

Active flood plains are usually found as narrow strips along the major streams. They constitute the most recent deposits and exhibit little or no soil profile development. Stratified layers of different texture still exist in the profile.

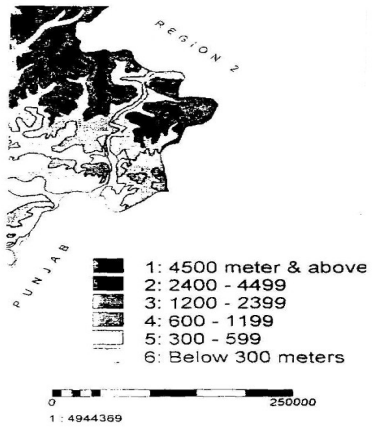


Figure 17: Elevation.

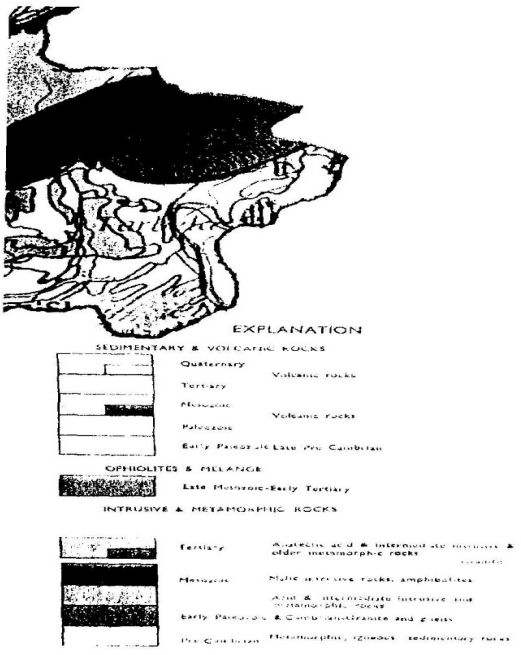


Figure 18: Geology.

SEVERELY ERODED LAND:

Parts of other landforms, which have been subject to such severe erosion that their original nature has been obliterated, are recognized as severely eroded land within the District. Deep, intricate gullies are the most conspicuous feature of the landform.

HYDROLOGY:

The Abbottabad District forms important watersheds for both Tarbella Dam in the West and Mangla Dam in the east. The rivers Jhelum, Kanshi, Haro and Dor mainly effect drainage of the District. The latter two, flowing mainly in South-Westerly direction, join the River Indus outside the District. The River Kanshi flows first in a Southerly and then in an Easterly direction to join the River Jhelum about 15 miles east from the District. The maximum discharge occurs in July, August and September, with a subsidiary peak early in the year as a result of winter rains. The flow of all the main rivers is perennial. The Kunar, Jhelum, Dor and Haro Rivers flow through the Eastern Hazara and AJK regions. These rivers are the major watersheds and have steep gradients with frequent cataracts. They flow through deep defiles and narrow valleys. A distinctive feature of these valleys is the repeated alternation of their wider sections, when they are parallel to the structural grain and where the rock is relatively soft, with intervening chasms and defiles. In the latter they are narrower and form gorges where they traverse hard rocks and make sharp bends across the structure.

Due to the deeply incised nature of the main rivers, groundwater over most of the survey area is mainly derived from precipitation. The markedly lower level of the river courses in comparison with the general land surface prevents infiltration of river flow to the general water table. Only in the narrow belts of river plains, where the groundwater is lower than the riverbeds, does recharge from surface flow result. Subsidiary channels draining the District are usually non-perennial in their upper and middle reaches, but become perennial in their lower reaches, where some groundwater discharge takes place.

In the river plains the depth of groundwater is about 30 to 50 feet. The quality is usually suitable for irrigation. A high percentage of successful wells are possible in these plains. The number of successful wells is low in the upland areas and water supply is very small, rendering irrigation schemes largely impracticable.

Figure 19: Drainage.

SOIL:

In 75 AD, Pliny, The Elder, the Roman naturalist, expressed his love for the earth. "The earth, gentle and indulgent, ever subservient to the wants of man, spreads his walk with flowers, and his table with plenty. Returns with interest, every good committed to her care and, although she produces poison, she still supplies the antidote; though constantly teased more to furnish the luxuries of man than his necessities. Yet even to the last she continues her kind indulgence and, when life is over, she piously covers his remains in her bosom." Thus, it is evident, that even 2,000 years ago, man was aware of the need to care for or conserve the soil. Sol conservation means the efficient use and management of the soil, thereby maintaining its productiveness over an extended period of time. The use and management of the soil includes planning to determine its proper use, preparation of the soil for planting, and treatment of the soil for the production of plants, including field crops, vegetables, forage and trees. The most materially advanced nations of the world recognize that the sources of their wealth are their land and water resources. It is these two resources that are the foundation of their agricultural and industrial strength. All segments of their economy and high standards of living are built largely upon the abundance and fruitfulness of their land and water. Way back in the 1930's, it was realized in the United States, that there was an urgent need for farm conservation. The Soil Conservation Service was initiated and soon it became evident that though good work was being carried out, as soon as the Government men left the programs initiated by them were abandoned. In areas, where farmers were actively involved in project activities, the efforts were crowned with success and programs were maintained. Thus the idea of Soil Conservation Districts emerged. Between 1937 and 1947, legislation was passed, enabling farmers to band together to form Soil Conservation Districts. Although there was no compulsion, soon over 90 % of U.S. farmlands were covered by these Districts. Today, with the emergence of Community Based Organizations and Cluster Groups within the Districts of Pakistan, as well as the emerging District Devolution Plan, there is a need to create District Soil, Water & Forest Conservancies. Any landowner, or tenant, with conservation problems, should be able to approach the directors of the Conservation Programs. A qualified conservationist should survey the problem. If it is decided that a group solution is required the local community should be asked to take up the problem in order to deal with it more efficiently. At this point the following steps should be carried out.

9.1 Scientific inventory of the land.

9.2 Aerial photography or Satellite Imagery showing soil, slopes, degree of erosion, land use and other features pertinent to the problem.

9.3 Conservation Plan Preparation.

This plan could include how each pasture; field and wood lot should be handled to conserve the land while maintaining high production. Suggestions for more efficient farm operations may include alteration of field lines; terracing; crop rotation; fertilization regimes; farm ponds and water harvesting; drainage and irrigation, including grass waterways; wood lots; and alternate high income crops, on community farming and marketing basis, can be indicated. Once all details are decided, in keeping with financial resources including farmer input and loans, a Conservation Plan is worked out. An agreement is entered into and technical assistance is provided. Local communities provide labor and implementation is carried out by them. Related specialists provide supervision and technical assistance. This program has proved to be successful in the U.S. and can be carried out here in Pakistan. Not enough emphasis can be placed upon the pressing need for doing so. Millions of acres, that are producing well below

capacity and at the same time are being swiftly depleted, can be converted to produce the abundance that is inherent within them. All this needs to be carried out immediately, before the depletion reaches a stage where it will be extremely expensive to reverse the trend.

The soils of the District have developed from wind and water laid deposits and from sedimentary rocks, and are predominantly dry-farmed for subsistence cropping.

Soils developed in wind deposited materials are dark brown to dark yellowish brown in color, have medium to fine textures and are very deep. Most of them have well-developed profiles containing lime concentrations at some depth. Some are subject to considerable erosion by water from the upland areas and from local runoff.

Water laid deposits contains a variety of soils whose characteristics are primarily dependent on the age and origin of the materials and their mode of deposition. The soils of the piedmonts and old flood plains have weakly developed profiles and consist of very deep, well-drained, brownish soils of varying textures. The weakly developed soils consist of dark grayish brown, silty clay loams or silty clays. The soils of the young flood plains show little profile development and comprise deep, well-drained, brown to dark brown, sandy loams to silt loams.

In the rock plains, sandstones and shales, lying close to the surface, have weathered to form well-drained soils which reflect the nature of the parent rocks. Soils on sandstones are brown to dark brown in color and have coarse to moderately fine textures high in sand content. They are mainly deep and have weakly developed profiles. The soils developed from shales are moderately deep, reddish brown and are of moderately fine texture.

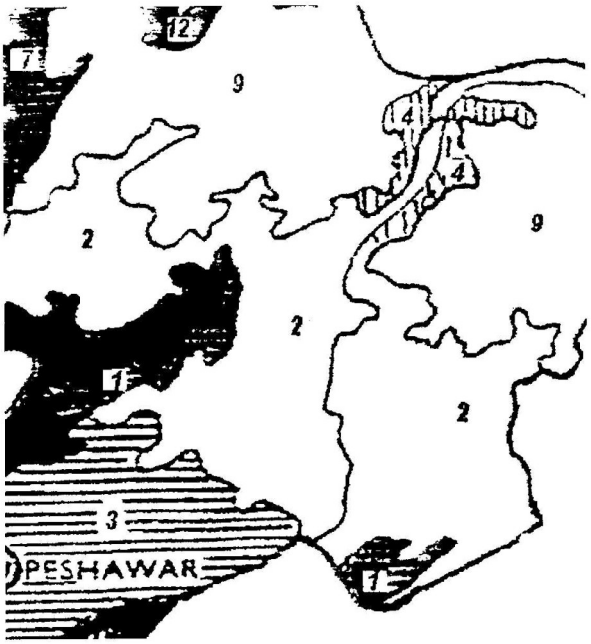


Figure 20: Generalized Soils.

1: Loamy & Clayey, mainly non-calcareous, or alluvial or loess plains/ terraces.
2: Mainly steep, loamy, shallow soils or some rock outcrops of humid mountain regions.
3: Loamy and Clayey, part non-calcareous soils of alluvial or loess plains/ terraces.

4: Mainly steep, Loamy, shallow soils and rock outcrops of sub-humid mountainous ranges.

9.4 SOIL EROSION:

The mountainous ridges on both Eastern and Western sides of the District are deeply eroded. The main factors for this are:

9.4.1 Environmental.

9.4.2 Social and economic.

9.4.3 Political and institutional.

There is extensive rainfall during the summer monsoon. This results in numerous hill torrents. This in turn causes flash flooding. Thus the major risk of erosion is in summer. The period between May to August provides a window of maximum rainfall, with minimum crop cover due to harvest of wheat and planting of maize. In many parts of the District, man, due to misuse of land and the unscientific management of various soil classes aggravates erosion. Deforestation and over grazing on fragile mountain slopes is a major contributor. Farming often does not follow the contour and land use is often inappropriate. Since tenants till the majority of the land, they do not go in for expensive conservation practices. They have meager resources and avoid sinking capital into the land. Land sliding, stream bank erosion, gullying, sheet wash, splash and rill erosion is in evidence. Fertile topsoil is constantly being lost, leading to siltation lower down. Deforestation on the Western and South-Eastern sides of the District has made more excessive erosion. Reduction of the Forest canopy on the East is also causing problems. This leads to exposure of tree roots and eventual death of the trees.

9.5 RECOMMENDATIONS:

9.5.1 Thorough inventory and survey of land. Showing land capability in order to prepare recommended land use maps.

9.5.2 Mulching and inculcation of compost into the soil.

9.5.3 Encouragement to no till permanent beds.

9.5.4 Crop cover in monsoon season.

9.5.5 Crop rotation.

9.5.6 Strip-Cropping.

9.5.7 Planting of windbreaks.

9.5.8 Proper terracing including platform, retention and bench terracing as well as land leveling.

9.5.9 Rodent Control.

9.5.10 Conservation Irrigation {Sprinkler, bubbler, drip, reticulation (sub soil)}.

9.5.11 Bunds to control surface runoff.

9.5.12 Water Harvesting and storage.

9.5.13 Reforestation and stratification.

9.5.14 Growing forbs and shrubs for forage.

9.5.15 Grass waterways.

9.5.16 Land protection by erosion control structures.

9.5.17 Small Dams.

9.5.18 Proper land use according to capability.

9.5.19 Controlled grazing.

9.5.20 Horticulture crops from fruit trees and bushes with proper nutrition to avoid disease and pests.

9.5.21 Proper road construction with drainage and maintenance.

9.5.22 Storm drainage.

9.5.23 Aquifer Recharging.

10. MAJOR SOIL SERIES[1]:

The soil series of Abbottabad belong to the order of Inceptisols and sub group Chromudertic Haplaquepts.

10.1 BASIN PLAIN.

Nearly level Basin Plain.
Abbottabad Association, Sub-Humid.

This comprises the Rash Plain with nearly level to concave areas and is about 8 square miles. Subsoil characteristics comprise Silty clays to silty clay loams, This association occurs only in sub-humid areas and is cultivated by means of irrigation from perennial springs. The main crops grown are maize and wheat. The quality of irrigation water is high and with provision of adequate drainage, production can be intensified. High priced vegetable crops are being grown in small quantities. Common vegetables like cauliflower and radish are grown at a larger scale. Provision of adequate drainage, addition of compost and the introduction of leafy vegetables are some of the possible improvements in the soil. The soils respond well to balanced fertilizers. Phosphate fertilizer should be placed. Limitations are, inadequate drainage, low winter temperatures, heavy soil texture and difficult seed bed preparation. The Abbottabad series consists of very deep, somewhat poorly drained, calcareous, fine textured soils developed in Subrecent mountain outwash deposits derived mainly from Tertiary semi-consolidated slates, metamorphic schists and granites. These soils have a cambic B-horizon. They have a dark grayish brown, friable, moderately calcareous, silty clay loam topsoil with moderate granular structure. This overlies a very dark grayish brown, firm, moderately calcareous, silty clay, B-horizon with weak coarse, subangular blocky structure. The sub stratum is very dark grayish brown, distinctly mottled, very firm. Slightly calcareous, massive silty clay. The water table fluctuates from 30 to 76 cm from the surface. Average rainfall is 114 cm most of which is received during mid June to September in the form of high intensity rain. Frost is frequent from November to February. Snow falls in December and January but is very small in quantity and usually thaws quickly. November and May are the driest months. Natural vegetation has been cleared for cultivation. The soils are restricted to the Basin Plain adjacent to the City of Abbottabad and are of small extent.

Small, nearly level, to concave, low areas are occupied by a poorly drained variant with darker and more olive colors and clayey textures in the topsoil. The water table is within 18 inches for most of the year.

Table 2: LABORATORY RESULTS:

S/No	Depth. Inches	USDA particle size Distribution (mm) (%)			pH	E.C.X. 103 cube mmhos. Per cm.
		Sand	Silt	Clay		
1	0- 5	8	56	36	7.9	1.97
2	5-14	10	54	36	8.1	1.10
3	14- 20	16	52	32	8.1	1.30
4	20- 32	10	44	46	8.0	1.34
5	32- 60	12	34	34	8.0	2.10

[1] Regional Soil Survey Report, Rawalpindi Area, Soil Survey of Pakistan.

10.2 PIEDMONTS.

Undulating, Dissected, Piedmont Plains.
Gullied Land, Chamba Complex. Sub-Humid

This association occurs only in sub-humid areas with average rainfall exceeding 35 inches. The association is dry farmed wherever possible, maize being the sole main cop. Winter cropping is limited by low temperatures. Grazing and grass cutting is practiced on gullied land. Land position consists of un-terraced steep sides of gullies; sloping or undulating lower slopes; terraced, moderately sloping sides of gullies and terraced gently sloping high areas. Winter temperatures are low, the terrain is rough and there is a hazard from erosion. Protection by restrictions on grazing and encouragement of controlled grass cutting is recommended. Stones can be removed in better areas. Improved leveling of terraces and provision of means of water disposal/ harvesting are some of the possible improvements. Intensive local conservation measures need to be adopted. Increase in intensity of cultivation through irrigation from small dams is possible. Wide scale improvement is not possible. However, three-dimensional shrubs, forbs and grass improvement with controlled grazing is possible. Stratified re-plantation of forest on upper slopes is recommended. This is especially true for the Western, Siwalik Range of the District. This area has been denuded of forest cover and it is recommended to try Seabuck Thorn of moist temperate variety along with Pine.

10.3 MISCELLANEOUS LAND TYPES.

10.3.1 Stony Land.

This is steep, predominantly stony land with local relief less than rough broken land (25 ft to 300 ft). The area has a cover of sparse vegetation of shrubs and low trees. Runoff is high and erosion is active. The area, as a whole, is poor grazing land. In some areas, stones are quarried for building material.

10.3.2 River Wash and Water.

Open water includes gullies in-between the river wash, which carries water all the year round. River wash is seasonally flooded, unstable sandy material in the bed of streams. Exposed at low water and subject to shifting at high water.

10.3.3 Badland.

This land occurs in the Dissected Basin Plains. It is steep or very steep, nearly barren land, ordinarily not stony, broken by numerous intermittent drainage channels. Geologic erosion has been active for centuries.

10.3.4 Rough Mountain Land.

This comprises mountainous areas, dominantly rocky or stony and includes very minor areas of shallow and very shallow phases of unidentified soils, partly suitable for cropping. The area generally supports scrub and grass vegetation that provides light grazing. Grass is cut for forage. Local relief is generally more than 500 ft.

MINOR SERIES ASSOCIATED WITH ABBOTTABAD ASSOCIATION[1].

11.1 **Ayubia Series.** Humid, Sub-Tropical, Continental.

Residuum as well as colluvium from non-calcareous shales. It is shallow, permeable, medium acid, slightly gravelly silt loam. This series lies on the slopes of mountains with 30 to 80 % slopes. It is covered Pine-Fir forest with mixed undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive with moderate to slight erosion. Mean annual rainfall is 1660 mm with two-thirds as summer and the remainder mostly as winter snow. Mean annual temperature is 13° C, winter and summer temperatures are 4° and 20° C, respectively. It has mostly Northern and Eastern aspects. However, at higher elevations it also has Southern aspects. Extent is limited and is confined to cool and humid, higher, forested mountains. Variants and phases are:

Ayubia moderately deep variant: solum more than 75 cm thick.
Ayubia silty clay loam variant.
Ayubia moderately steep phase; occurs on 13 – 25 % slopes.
Ayubia cultivated phase.

11.2 **Bagnotore Series.** Sub-Humid, Humid Tropical Continental.

Residuum as well as colluvium from lime stones. It occurs on the side slopes of mountains (30 to 80 %) and is generally North facing. It is found at elevations of 1,800 to 2,700 meters and is covered with Pine-Fir forests with mixed undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive and erosion is slight to none. The profile characteristics are moderate deep, very slightly to non-calcareous, permeable, slightly gravelly silt loams. Mean annual precipitation is 1,500 mm with about two-thirds as summer rainfall and the remainder mostly as snow in winter. The mean annual temperature is 17° C. Winter and summer temperatures are 8° and 24° C, respectively. Aspects are mostly Northern and Eastern with some Southern aspects at higher elevations. The series is moderately extensive and is confined to cool humid, higher forested mountain slopes. Phases and variants are:

Bagnoter moderately steep phase: occurs on 13 – 25 % slopes.
Bagnoter deep variant: solum more than 90 cm thick.
Bagnoter shallow variant: solum less than 50 cm thick.

11.3 **Baragali Series.** Sub-Humid, Humid Tropical Continental.

Residuum as well as colluvium from non-calcareous slates. The series occurs on the side slopes (25 to 80 %) of mountains and generally faces North. It lies at an altitude of 1,600 to 2,400 meters. The series is covered with Pine-Fir Forests with mixed undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive while erosion is slight to none. The profile characteristics reveal moderate deep, non-calcareous, permeable, gravelly silt loam. Climate is similar to Bagnotore series. It mostly consists of Northern and Eastern aspects with all aspects on higher elevations. The series is moderately extensive and is confined to cool humid and sub humid forested mountain slopes. The phases and variants are:

Baragali cultivated phase.
Baragali deep variant: solum more than 90 cm thick.
Baragali deep variant, cultivated phase.

[1] An Internship report on Activities of Soil Conservation in Hazara Division, Miss Maria Mussarat, 1996.

Baragali moderately steep phase: occurs on 13 – 25 % slopes.
Baragali shallow variant: solum less than 50 cm thick.

11.4 **Barian Series.** Sub-Humid, Humid Tropical Continental.

Residuum from marls. This series occurs on moderately steep terraced mountain slopes (6 to 13 %). It lies at an elevation of 1,200 to 1,500 meters. It is dry farmed with wheat and maize, drainage is excessive and erosion is moderate to slight. Important profile characteristics consist of moderate deep, strongly calcareous, permeable, slightly gravelly silty clays. Mean annual precipitation is 1,300 mm, of this two-thirds is in summer and the rest as winter snow. Mean annual temperature is 13° C. Winter and summer temperatures are 4° and 20° C, respectively. It lies on all aspects and is minor extensive, confined to mountainous terrain in the South East of the area. Its phases and variants are:
Barian forested.
Barian shallow variant: solum less than 50 cm thick.

11.5 **Kohala Series.** Sub-Humid, Humid Tropical Continental.

Residuum as well as colluvium from calcareous red shales and sandstones. It lies on the side slopes of mountains (25 – 60 %). It is found at elevations from 750 to 1,200 meters. Vegetation is mainly scrub with scattered Pine trees with mixed undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive while erosion is slight to moderate. The profile characteristics are moderately deep, strongly calcareous, permeable, slightly gravelly loams with rock within 75 to 90 cm depth. Mean annual rainfall is 1,600 cm and temperature is similar to Barian series. It is found on all mountain aspects. The series is moderately extensive and occurs mainly on the Eastern part of the area. Phases and variants are:
Kohala clay loam variant.
Kohala clay loam variant cultivated.
Kohala cultivated.
Kohala deep variant: solum more than 90 cm thick.
Kohala moderately steep: occurs on 13 – 25 % slopes.
Kohala shallow variant: solum less than 50 cm thick.
Kohala stony variant.

11.6 **Makhnial Series.** Sub-Humid, Humid Tropical Continental.

Residuum as well as colluvium from limestone. This series occurs on the side slopes of mountains (25 – 80 %). It is found at elevations of 600 to 1,200 meters. Vegetation consists of scrub at low altitudes and Pine on higher altitudes with undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive and erosion is moderate to severe. Important profile characteristics are shallow, moderately to strongly calcareous, massive to granular, permeable, slightly gravelly silt loams. Mean annual precipitation is 1000 mm. Of this two-thirds falls in summer and the rest during the winter. Mean annual temperature is 21° C. Winter and summer temperatures are 11° and 30° C, respectively. It is found on all aspects of mountainous terrain. The distribution is very extensive and occurs on all humid and sub-humid mountain slopes. Its phases and variants are:
Makhnial cultivated.
Makhnial deep variant: solum more than 90 cm thick.
Makhnial moderately deep variant: solum more than 75 cm thick.

Makhnial moderately deep variant cultivated.
Makhnial non-calcareous surface.

11.7 **Thirpa Series.** Sub-Humid, Humid Tropical Continental.

Residuum as well as colluvium from non-calcareous slates. This series is found on steep side slopes of mountains (25 – 70 %). Vegetation consists of scrub and scattered Pine trees with undergrowth of shrubs and grasses. Drainage is somewhat excessive to excessive and erosion is moderate to severe. The important profile characteristics are shallow, non-calcareous, permeable very characteristic gravelly silt loams. Climate is similar to Makhnial series. Extent and distribution are most extensive but confined to Northern parts of the area. Phases and variants are:
Thirpa cultivated.
Thirpa moderately steep: 13 – 25 % slopes.

VEGETATION AND LANDUSE:

12.1 Forest Area: This is a predominant aspect of the Eastern side of the District, is reported (1996 – 97/ Hectares) in the Galliyat area as 2,122 Under Sections 38.15 and 16, 36,362 under Forest Department 'Guzara Forest' and 809 under Community Plantation. This shows 54,851 total and a total of 83,201 for the entire District. There are two types of distinctions made for Vegetation type. Champion et al (1965), have described nine forest types and according to the BIOME3 model (Prentice et al 1992; Haxeltine, 1996) there are 17 biomes worldwide. A Biome is a broad physiognomic vegetation classification recognized by plant formation types or dominant plant types. The original vegetation of the area has been mostly cleared with few natural jungles remaining in the Eastern portion of the District (Galliyat). Trees in the higher elevations of the District are:

Table 3: Himalayan Moist Temperate Forests (Champion et al) or Temperate Conifer/ Mixed Forest Biome (1500 – 2500 m)

Common Name	Botanical Name
Douglas Fir	*Abies pindrow*
Deodar	*Cedrus deodara*
Oak	*Quercus spp*
Blue Pine – Kail	Pinus Wallichiana

The second zone that lies within the District has few tree associates in the under-story and scant undergrowth. It consists of:
Table 4: Himalyan Sub Tropical, Moist, Chir – Pine Forests (Champion et al) or Warm Conifer/ Mixed Forests Biome (1050 – 1600 m)

Common Name	Botanical Name
Pine – Chir	*Pinus-Longifolia, Roxburghii*
Pine – Batangi	*Pinus Pashia*
Oak	*Quercus incana*
Walnut	*Juglans regia*

In the lower portions of the District we find vegetation consisting of:

Table 5: Dry Sub-Tropical Broad-leafed Forests (Champion et al) or Xerophytic Wood/ Scrub Biome (500 – 1050 m)

Common Name	Botanical Name
Wild Olive – Kao	*Olea cuspidata*
Mulberry – Toot	*Morus alba*
Kikar	*Acacia arabica*
Phulai	*Acacia modesta*
Karir	*Capparis aphylla*
Shisham	*Dalbergia sissoo*
Palwara	*Tamerix Articulata*
Tun	*Cedrela toona*

Thus three types of Vegetation zones, or Biomes, are found within the District.
In the upper reaches undergrowth consists of:

Table 6: Alpine and Sub-Alpine scrub.

Common Name	Botanical Name
Booi	*Plectranthus rugoses*
Sumblulu	*Barberis lycium*
Gush	*Viburnum continifalium*
Mushkbala	*Valeriana wallichii*
Dodal	

In the lower reaches we find:

Table 7: Mixed Scrub.

Common Name	Botanical Name
Sanatha	*Dodonaea viscosa*
Loonder	*Thameda anthera*
Daruni	*Punicia granatum*
Granda	*Carisba spinarum*
Malla	*Ziziphus nummularia*
Chititi booi	*Otostegia limbata*
Walayati Aak	*Ipomea Cornea*
Marvon	*Vitex Negundo*
Dhaman	*Grewia oppositifolia*

12.2 Cultivation: The agriculture in the area is primarily concerned with the production of food crops. Of the cultivated area, only a minor part is irrigated. The remainder is dry-farmed. On the irrigated parts some vegetables are grown. Dry-farmed and irrigated fruit orchards are found in small sizes. At one time there were plenty of Apple Orchards. These have now mostly succumbed to Powdery Mildew.

CHAPTER 2: AGRICULTURE IN ABBOTTABAD DISTRICT:

1. CURRENT STATE:

Area 1802 Square Kilometers.

Altitude Abbottabad City: 1222 M

†Table 1[1]: Total population by Sex and Rural Areas:

TOTAL	FEMALE	MALE	RURAL
875157	439231	435926	717737

Increase over 1981 – 1998 = 35 %: Growth Rate per Annum = 1.79 %

Population density = 485.7 per Square Kilometer.

1.1 Age Classification:

1.1.1 0.1 – 14 years 308776

1.1.2 15 – 64 years 34062

1.1.3 65 plus 29950

1.1.4 Total Dependency = 99.45 %

1.1.5 Child Dependency Ratio = 90.66 %

†Table 2: Land Utilization Statistics (Hectares):

Sown	Fallow	Sown Twice	Cult. Waste	Forest	Not Aval.	TOTAL
49472	13900	7144	12586	83201	19242	178401

1.2 Cultivation Classification:

Total Cultivated Area 63372 Land Use Intensity = 83.43 %

Total Cropped Area 56616 Cropping Intensity = 89.33 %

Population per cultivated hectare = 14 persons.

Population per irrigated hectare =126.9 persons.

†Table3: Number and Area of Farm by Size: (Hectares).

Cat.	All Farms	Govt	Pvt.	< 1	1 to 2.5	2.5 to 5.0	5.0 to 7.5	7.5 to 12.5	12.5 to 25	25 to 50	50 to 150	> 150
Area	137719	------	137719	33716	42557	32476	13432	9953	4492	89	190	9

2. CROPS & ALLIED DATA:

†2.1 Table 4: Major Crops:

ITEM	Area in Hectares			Production in Tons			Yield/ Hectare	
	Irri.	UnIrri.	Total	Irri.	UnIrri.	Total	Irri.	UnIrri.
Maize	1304	33894	35198	2394	42977	45371	1836	1262
Wheat	1040	17447	18487	1813	22300	24113	1743	1278
Rice	46		46	58		58	1261	

2.2 Production per Capita:

2.2.1 Maize: 51.09

2.2.2 Wheat: 27.15

2.3 †Table 5: Minor Crops:

[1] Abbottabad District Census Report, 1998. All tables marked †.

ITEM	Area in Hectares			Production in Tons			Yield/ Hectare	
	Irri.	UnIrri.	Total	Irri.	UnIrri.	Total	Irri.	UnIrri.
Bajra		5	5		2.6	2.6		520
Jowar		38	38		32	32		842
Barley		123	123		109	109		886
Rape & Mustard		47	47		33	33		702

2.4 †Table 6: Pulses:

ITEM	Area in Hectares			Production in Tons			Yield/ Hectare	
	Irri.	UnIrri.	Total	Irri.	UnIrri.	Total	Irri.	UnIrri.
Mung	4	1	5	3.38	0.82	4.2	845	820
Mash	5	14	19	2.97	7.7	10.67	594	550
Other Kharif Pulses	4	1	5	1.45	0.35	1.8	360	350
Masoor		3.24	3.24		2	2		617
Other Rabbi Pulses	19	177	196	10	85	95	526	480

2.5 †Table 7: Fodder:

SEASON	ITEM	Area/Hectares	Production/Tons	Kgs/ Hectare
Karif	Maize	22	928	42182
	Others	56	2414	43107
	TOTAL	78	3342	42486
Rabbi	Shaftal	213	3910	18300
	Others	163	2300	14100
	TOTAL	376	6210	16500

2.6 †Table 8: Distribution of Improved Seed (Kgs):

WHEAT	MAIZE	TOTAL
51800	1000	52800

2.7 †Table 9: District Off-Take of Fertilizer (N/Tons):

Fertilizer	Nitrogenous	Phosphate	Potash	TOTAL
Nutrient Tons	2810.868	511.575	12.06	3334.503
Fertilizer/Cultivated/ Hectare	44.4	8.1	0.2	52.6

2.8 †Table 10: Agricultural Loans/ Abbottabad & Haripur (Rs in Millions):

BANK	Fertilizer/ Pesticide	TubeWells	Implements/ Tractors	Others	TOTAL
ADBP	1.106	25.016	2.221	20.252	48.595
Commercial	28.04				28.04

2.9 †Table 11: Tractors/ Bulldozers Data:

Owner	Bulldozer	Tractor	Wheat Thresher	Maize Sheller
Govt.	9	6		
Private		324	62	7

Cultivated land per tractor (97-98) = 0.19 Hectares.

2.10 Land Maps[1]:

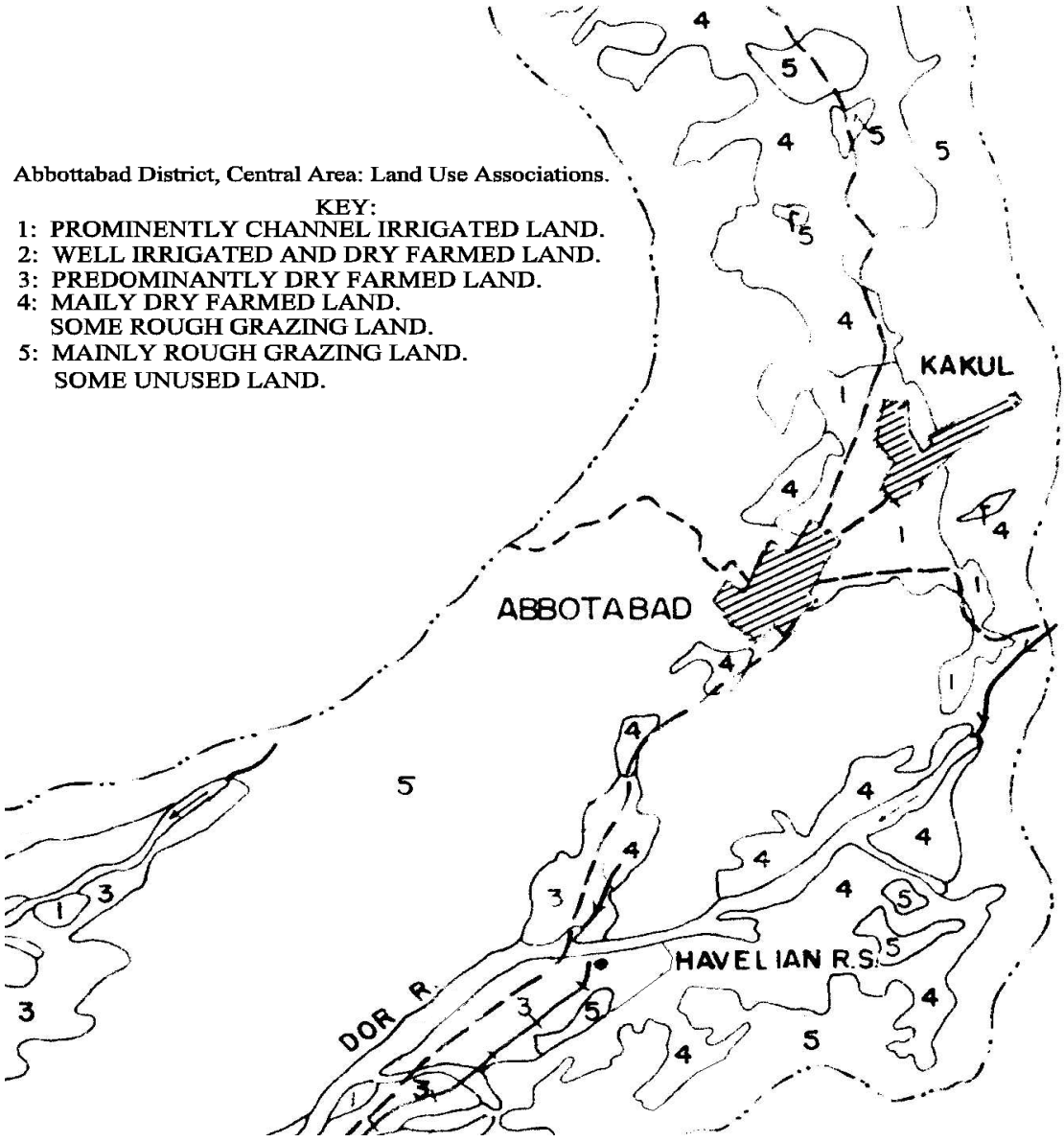


Figure 1: Land Use Associations.

[1] Regional Soil Survey Report, Rawalpindi Area, Soil Survey of Pakistan.

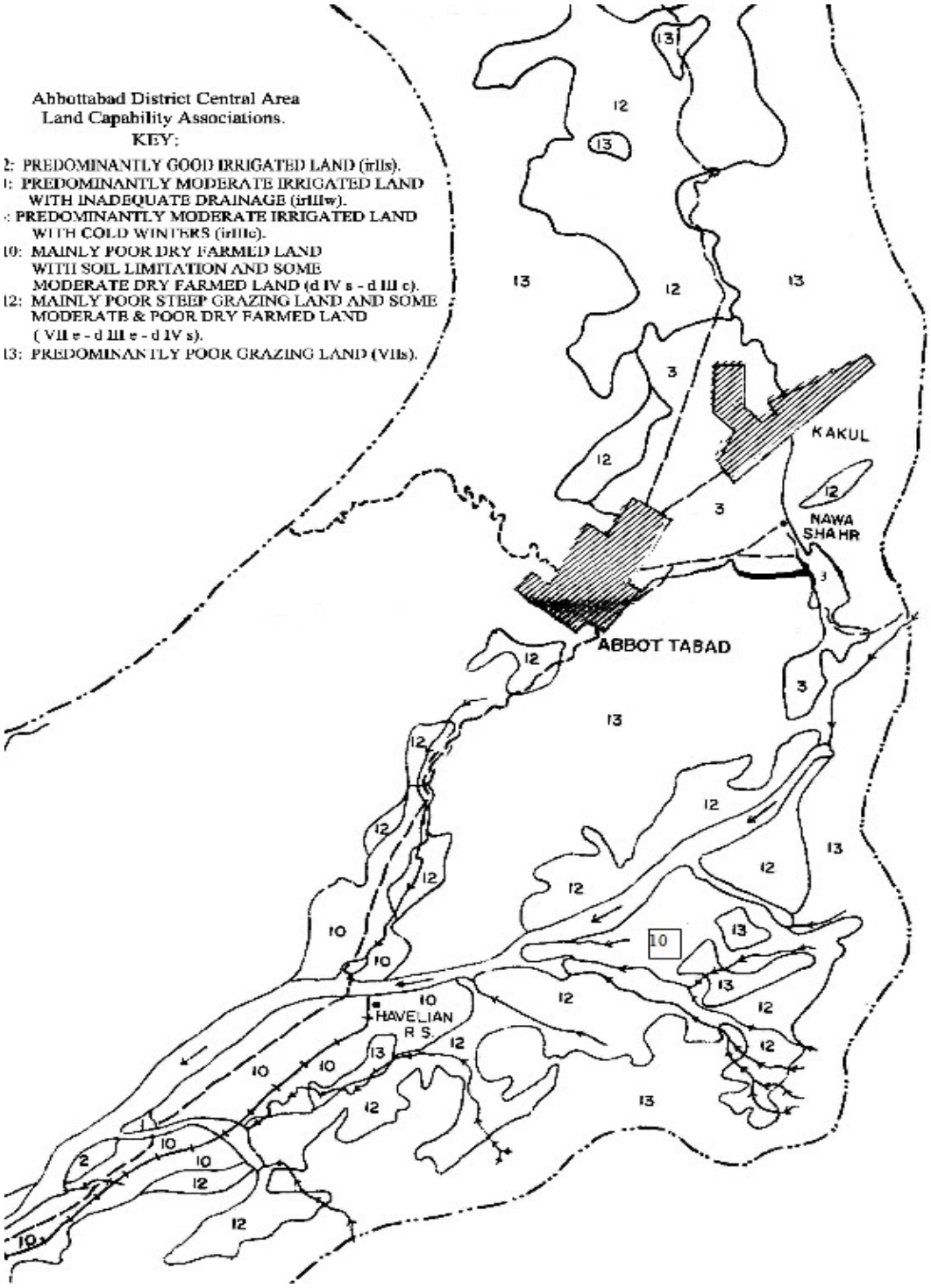

Abbottabad District Central Area
Land Capability Associations.
KEY:
2: PREDOMINANTLY GOOD IRRIGATED LAND (irlls).
1: PREDOMINANTLY MODERATE IRRIGATED LAND WITH INADEQUATE DRAINAGE (irlllw).
: PREDOMINANTLY MODERATE IRRIGATED LAND WITH COLD WINTERS (irllle).
10: MAINLY POOR DRY FARMED LAND WITH SOIL LIMITATION AND SOME MODERATE DRY FARMED LAND (d IV s - d III c).
12: MAINLY POOR STEEP GRAZING LAND AND SOME MODERATE & POOR DRY FARMED LAND (VII e - d III e - d IV s).
13: PREDOMINANTLY POOR GRAZING LAND (VIIs).
KAKUL
NAWA SHAHR
ABBOT TABAD
HAVELIAN R.S.

Figure 2: Land Capability Associations[1].

[1] Regional Soil Survey Report, Rawalpindi Area, Soil Survey of Pakistan.

3. **AGRICULTURE OVERVIEW:** For purposes of analysis the land in the District may be divided into three main Classes:
   a) Temperate Open Valleys.
   b) Temperate Hill Tracts.
   c) Cold Mountain Tracts.

3.1 The Temperate Open Valley is the Rash Plain. The Temperate Hill Tracts are situated due West, South West and South of this Plain. To the North East, East and SouthEast, the Cold Mountains gradually ascend in height to the Mushkpuri peak. This area is denoted as the Galliyat.

3.2 The Temperate Open Valleys receive ample rainfall, as elaborated elsewhere. Secondly, irrigation is available, though it needs to be developed. The temperate Hill Tracts are rainfed and like the plains, receive ample rainfall. Water Harvesting and subsequent Conservation Irrigation can lead to a manifold increase and intensification in agriculture and horticulture. This is where a large part of horizontal and vertical increases can be had. Both the Temperate Valleys and the Hill Tracts are faced with cold winters and occasional light snowfall in January and February. The Kharif crop is certain but Rabbi season also yields some maize for both human and animal consumption. Grazing is ample and grasses are harvested before the advent of winter.

3.3 The Cold Mountains face severe and prolonged winters and temperate summers. Precipitation is ample with monsoon rains in late summer and heavy snowfall in winter. This in fact exceeds the rest of the District. Rabi crops are small, sometimes with the advent of the monsoon rains before wheat is ripe. Maize and some Rice are grown in this area. The Maize crop sometimes suffers from the fall of hailstones. Land holdings are small and population pressure forces many of the male members to seek employment in the larger Cities of the Country. Many have found employment in the Middle East. Villages are usually abutted with good, though small, agricultural land. Fruit and vegetables are grown to a small extent. The Bakot Union Council area is Rice growing, though the rough Mountain Rice is of inferior quality. Some Barley and inferior Pulses are also grown.

4. SUMMARY OF DEVELOPMENT POTENTIAL:

4.1 Statistics: Most of the easily cultivable land within the District is already cultivated. However there exist a great potential of increasing this both horizontally and vertically. As per Agricultural Statistics 1998–1999, of the Govt. of the N.W.F.P.

Table 12[1]: Land Use Statistics:

Serial Number	ITEM	Area (acres)	%
1	Total Land:	178401	100.00
2	Not available for cultivation.	19242	10.78
3	Forest.	83201	46.63
4	Cultivable waste.	12586	7.05
5	Fallow.	13900	7.79
6	Sown.	49472	27.73
7	(Sown twice).	(7144)	4.02

4.2 Analysis: Only 10.78 % is not available for cultivation. A total of 7.05 % is represented as cultivable waste, while 7.79 % lies fallow. Thus 14.84 % of available land is presently not

[1] Agricultural Statistics 1998–1999, of the Govt. of the N.W.F.P.

being used for agriculture. A total of 27.73 % of the Districts land is under cultivation. However, out of this figure only 4.02 % is sown twice. This too is producing dismally due to a variety of reasons elaborated elsewhere. Thus 23.73 % of the land is under utilized. The following figures emerge from this analysis:

Table 13: Land Increase Potential:

Serial Number	ITEM	Area (acres)	%
1	Land available for Horizontal Increase:	68809.26	38.57 %
2	Land available for Vertical Increase:	75980.98	42.59 %

4.3 Measures: Thus economic increase can be had in a large quantity of land. This can be done through:

4.3.1 Survey of land and classification according to Land Capability.
4.3.2 Recommended and implemented Land Use and Improvement.
4.3.3 Adoption of modern management practices including strip cropping and crop rotation in accordance to Land capability.
4.3.4 Design and construction of Soil Conservation measures including Retention Terracing.
4.3.4 Formation of District and Union Council Soil Conservation Associations.
4.3.5 Installation of Tile Drains in Central Rash Plains.
4.3.6 Increasing organic content of the soil by use of mulches, compost and/or green manuring.
4.3.7 Adopting Water Conservation Measures. Formation of District and Union Council, Water Conservation Associations. Training and assistance for Conservation Irrigation. Recharging wells for aquifer replenishment.
4.3.8 Use of Biological Agents (earthworms, Rhizobium bacteria etc.).
4.3.9 Use of environmentally safe and stabilized mineral fertilizers and soil amendments.
4.3.10 Improved crop varieties, seed certification, disease resistant rootstock.
4.3.11 Intensive Agriculture, Horticulture and Floriculture can be readily practiced.
4.3.12 Provision of skills through permanent Institutions based in the area.
4.3.13 Crop Protection through:
a) Proper Nutrition.
b) Environment Control.
c) Biological Pest Control.
4.3.14 Community Based Marketing and “Growing for Export.”
4.3.15 Provision of Storage; Cold Storage; Processing and Packaging Facilities.
4.3.16 Construction of Small Dams, e.g. in Rajoya (about 2000 hectares can benefit).

4.4 Irrigation, Soil Conservation and Proper Plant Nutrition, along with provision of quality inputs in the shape of seed and root stock will prove to give a tremendous boost to Agricultural and Horticultural Production in the District. Much Revenue and Employment can be generated through this Sector alone. At present we are utilizing roughly 61 % of Horizontal Production and 57 % of Vertical Production. There is plenty of water available in the District in the shape of flowing water from streams and springs as well as adequate rainfall in two seasons. Instead of utilizing these two sources adequately the Public Health Engineering has gone in for expensive Tube Wells that have depleted the Aquifer. Due to deforestation in the Western half of the District and steep grades there is inadequate recharging of the aquifer. This may lead to crisis situation in the near future. Immediate steps can and should be taken to rectify the current

situation. Bacteriological and Physico-Chemical Analysis from reliable sources (Chapter 5), show that the ground and surface water is being increasingly polluted with Faecal Coliforms and increasing Nitrate levels.

4.5 On-Ground Realities: From the above table it seems that Forest cover in the District is adequate (46.63 %). However, the quantity of trees and the quality of growth is another question. The Provincial Forest Resource Inventory (PFRI) of December 2000 from the GIS Laboratory[1] in Peshawar shows quite another picture. There are also some conflicts in areas.

Table 14: Land Use Statistics GIS:

Sr.	LAND CLASS	AREA (HECTARES)	% DENSITY (Average)	ACTUAL AREA AT FULL DENSITY
1	Forest.	16481.5	10 – 25 % (17.5)	2884.26
2	Forest.	9546.8	26 – 50 % (38.0)	3627.78
3	Forest.	10366.3	> - 50 % (75.0)	7774.72
4	TOTAL Forest.	**36394.6**	**(60.75 % missing)**	**14286.76 (39.25 %)**
5	Agricultural Land.	86589.3	(Intense 8.25 %)	7144
6	Shrubland.	1759.03	0.98 %	1759.03
7	Rangeland & Sparse Vegetation	51445.2	28.63 %	51445.2
8	Waterbodies.	228.6	0.13 %	228.6
9	Riverbeds & Sedimentation.	1248.7	0.7 %	1248.7
10	Built up Areas.	1325.3	0.74 %	1325.3
11	Area not covered.	662.77	0.37 %	662.77
12	TOTAL.	**179653.5**	----------	**179653.5**
13	TOTAL Land available for Intensive use.	**79445.68**	(91.75 %)	**86589.3 (100 %)**
	TOTAL FOREST AREA.	**53896 (30 %) Plantation**	7.95 % (Dense)	**39613.6 Requires Full Plantation**

4.6 Analysis: The above table shows that a total of 79445.68 hectares of agricultural land is available for intensification (horizontal increase). Also 39613.6 hectares of Forestland need to be planted to bring Forest cover to 30 % of the Districts area for sustainable Forest cover.

The 51445.2 hectares shown as Rangeland and sparse vegetation also needs re-vegetation with the 3 dimensional approach of Grasses: Forbs: Shrubs in order to make it sustainable for grazing. Rangeland management needs to be introduced of this land which represents 28.63 % of the Districts area. A further 1759.03 of Shrubland (0.98 %) also needs re-vegetation. All these figures show that there is plenty of scope for improvement in the Green Sector of Development. This will make for Sustainability as well as generate employment and thus stimulate the economy. At present the Area is mismanaged and needs immediate attention.

5. DEVELOPMENT CONSTRAINTS:

[1] Courtesy, Swiss Development Corporation- InterCooperation (SDC-IC).

5.1 Background: A brief review of the Problems and Development Constraints that have been observed in the area should go a long way towards resolving these issues. Thus making for more, better and sustainable development.

5.1.1 Constraints:

a) Resistance to Change: The Human Psyche is ingrained with resistance to change. This factor has to be given due consideration.

b) Sedentary Versus Pastoral: It has been found that Cattle, sheep and goat grazing, by locals is causing a lot of damage to an already fragile Eco-system.

c) Non-Organic Soils: Closely linked to the above two points is the serious problem of lack of Organic Material in the soil. Soils are depleted of Nutrients due to erosion and leaching. No, or very little degraded organic material is inculcated into the soil. The addition of harmful substances like unstabilized Nitrate Fertilizers and harmful chemical Pesticides have killed all Biota present in the soil. All this curtails produce tremendously. Humic content and Friendly bacteria are practically non-existent.

c) Poor Water Resource Management: There exists a lot of room for improvement in Water Resource Management. At present the farmers are either totally dependent upon rainfall (Barani) or are employing flood irrigation. There is scope for the construction of Mini Dams.

d) Lack of Crop Related Research: Farmers are engaged in following time honored cropping patterns. There is no research what so ever relating to new and better crops and timings. What little that has been done, such as the introduction of Canola, is sabotaged by supply of poor quality seed.

e) Credit: Absence of low interest Capital is a major limitation as inputs are severely curtailed due to lack of capital. What little is available is subject to delay and mal-practices. Delay in releasing funds for time sensitive crops is not the correct method of Credit Disbursement. Even a few days delay can cause severe loss in yields. This, in turn, lowers profit margins and even wipes them out. Lack of finances creates a situation wherein the best use of land is not possible.

f) Seed: It has been observed that seed purchased by most farmers is sub-standard. This causes a lot of loss to the farmers. Time, effort and money is wasted, as returns from poor seed are not sufficient to make the effort cost effective.

g) Poor Cultural Practices: The tractor is a specialized tool. It has been found that mechanical skills in cultivating the land are sorely lacking. Lands are badly leveled. Contour Farming needs to be improved. Soil erosion is being aggravated by not catering for drainage. Freshly plowed land is subjected to torrential rain, the topsoil falls prey to sheet erosion. Deep plowing is carried out in the wrong season and too often. Crop rotation and green manuring is not practiced. All these factors have led to sorely depleted soils. Orchards too, face many problems. Pruning is hardly ever carried out. Secondly, cultivation around Fruit Trees is carried out in a harmful manner, i.e. too deep and not restricted to the Drip Line of the tree's foliage. Thirdly, efficient systems for irrigation are not adopted. Fourthly, fertilization with organic and stabilized nutrients is sorely lacking. All these factors curtail yields severely as well as produce unhealthy fruits; diseased and Pest-Prone trees.

h) Use of Unstabilized Fertilizers/ Dangerous Pesticides: Both Urea and DAP contain Nitrogen that rapidly converts to Nitrate Form or is already present in that form.

Dangerous and even banned but locally available Pesticides are also causing irreparable damage.

i) Inefficient Fertilization: Broadcast fertilization is wasteful and actually leads to encouraging competition between crops and weeds.

j) Plant Nutrition: The concept of plant nutrition seems to have escaped our attention. The fertilizer regime, as recommended by our Agriculture Department, is outdated. There is no recommendation for Potassium. Secondary and MicroNutrients are not used.

k) Lack of Technical Support: The Extension Service of the Agriculture Department leaves much to be desired. They are either under-qualified or do not have enough facilities to be able to carry out their jobs.

l) Absence of Crop Insurance: Being totally at the mercy of nature is not conducive to encouraging Farmers, Investors or Credit Institutions. Uncertainty engendered by changing weather patterns leads to extreme caution on the part of the farmer.

m) Lack of Storage/ Cold Storage/ Proper Transport Facilities: This factor obviously effects Horticulture tremendously. The farmers are almost blackmailed into selling their produce at the lowest possible rates.

n) Lack of Infrastructure in Rural Areas: Pakistan has a Rural Road Density of 0.19 Km./ Sq. Km. which comes to 0.98 Km. per 1,000 individuals.[1] Of these 82 % roads are of "Low Type".[2] This leads to high cost of transport of inputs as well as produce. In turn, this pushes up the price of agricultural goods and reduces the profit margin for the farmer. Electricity is a major requirement for Irrigated agriculture. Even if conservation irrigation is used some form of power is required. Diesel and other fuel-operated engines are costly as well as create environmental pollution.

o) Poor Marketing Atmosphere: Here, as in other sectors of our Economy, there exists a Buyer's rather than a Seller's Market. For development, this situation needs to be reversed. The seller should not be blackmailed when he attempts to sell. The prevalent market situation discourages change from extensive to intensive farming.

p) Difficulties in Export: The number of difficulties and delays that an exporter has to face discourages many from attempting to export. Losses, caused by these factors, lead to a turning away from this most vital aspect of a Nations economy.

q) Lack of Information: Crop specific information is sorely lacking. Planting methods; densities; spacing; fertilizer and cultural requirements and timings are usually quite obscure.

r) Terms of Trade: The relationship between prices of farm outputs and inputs is a crucial issue. The barter terms of trade of agriculture and its subsectors (crops and livestock) was examined by the Prime Minister's Task Force on Agriculture in 1993. Movement between the periods 1981-82 and 1990-91. The study shows that barter terms of trade for major crops stood at 107.42 % in 1981-82 and was reduced to 86.97 % in 1990-91. This showed a negative trend of –20.45 %.[3] This reflects a decline in the purchasing power of farm outputs in relation to the manufacturing sector. Obviously, this takes away from the standard of living of the farmer.

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1 Agriculture Prices Study, John Mellor Associates, 1993.

2 Report of Prime Minister's Task Force on Agriculture, 1993.

3 Pakistan Journal of Agricultural Economics, Vol. 1, No. 1, 1992.

Table 15[1]: Commodities Required to buy Unit Nutrient of Fertilizer and one Tractor:

	Nitrogen		Phosphorus		Tractor	
Commodity	1981-82	1991-92	1981-82	1991-92	1981-82	1991-92
Wheat	2.73	2.55	1.92	3.37	57.1	64.2

s) High Cost of Farm Implements: despite the fact that Mini Tractors are being assembled in the N.W.F.P., there is no outlet for sales in Hazara Division, what to talk about Abbottabad District. Non-availability of implements and credit for their purchase, is a major impediment in the mechanization of agriculture.

s) Fiscal Policies: The maintenance of interventionist policies regarding agriculture in order to provide cheap food to urban consumers, cheap raw materials to Industry and to generate revenue for the exchequer has been no less than "Plundering of Agriculture in Developing Countries."[2] This study recommends that:

i. If a Country wants to achieve faster agricultural growth, faster economic growth and fewer poor people, it should stop taxing agriculture relative to other sectors.

ii. To stop taxing agriculture, a Country should eliminate the undue protection of industry and the over evaluation of the exchange rate (three-fourths of the tax).

iii. Dismantle the interventions in agricultural prices (one-fourth of the tax).

5.1.2 21st Century Agriculture Solutions:

a) Overcoming Resistance: This factor is readily removed with actual results on ground. Demonstrated excellence has proved that Seeing is indeed believing! Once the farmers see the difference with their own eyes, they are more amenable to change. Indeed the miserable economic conditions that prevail in the rural area's, make them eager to adopt demonstrably profitable methods.

b) Sedentary Versus Pastoral: Solutions must be found to restrict grazing. Confined feeding with nutrient supplements will better the quality of milk and meat. This alternate is expensive in the short term but extremely cost effective in the long term. Another alternate is the breeding of ruminants that do not harm the vegetation as much as the current feeding patterns. We have but one Eco-System. That too has been severely damaged.

c) Organic Soils: Composting with Effective Microbes can greatly speed up the process. Secondly Organic matter is increased four fold, by using this technique. The resultant quality and abundance in yields is a great incentive. This makes farming sustainable.

d) Water Resource Management: Production of Sprinkle Systems needs to be increased. Secondly, inexpensive Drip and Sub-Soil Irrigation can be practiced. Correct Water Harvesting practices during heavy rains provides a reliable reservoir in lean rainfall periods. Construction of Mini Dams can be undertaken.

e) Crop Related Research: Viable alternatives should be found and pursued. The process takes many years and is not profitable in the short term. When linked up with Universities and Agriculture Departments, costs can be underwritten or offset. A system of reward and recognition for Research that yields positive results will prove to be sufficient incentive to take on this task.

f) Genetic Modification: Biotechnology is poised to yield tremendous dividends in the New Millenium. This too, is facing resistance. It is pointed out that there is no such thing as

[1] Report of Prime Minister's Task Force on Agriculture, 1993

[2] World Bank Study, 1991.

"Natural Agriculture." Human beings have painstakingly modified genetic characteristics of wild plants over the centuries to produce the high yielding varieties of today. This has been done in the field in a slow and inefficient manner. With the advent of Genetic Engineering the same process is quicker and made more efficient in the Laboratory. True, much care and consideration with stringent checks and balances are needed. However, it is reactionary, to say the least, to reject modern science and advances. Teeming populations and their need for Food Security far override the so-called "Nature Farming" being advocated by some people. Transgenic plants that are drought, virus, insect and disease resistant are the order of the day. Nutrition enhancement is possible through protein enriched and high oil content varieties. Bio-engineered plants actually cut costs by reducing costly and environmentally damaging inputs and raise yields. Some Countries, like Italy, have placed a ban upon Genetically Modified Plants. However, the EU Scientific Committee on Food has rejected this ban by stating that Italy has not produced any evidence that these products pose a risk to human health.[1]

g) Credit: To disburse credit solely through Finance Specialists is not effective for Agriculture and Horticulture. Specialists should be associated with the process. This would ensure timely disbursement for viable efforts.

h) Seed: Certified seed is essential to Agriculture and Horticulture. Strict penalties should be imposed on the sale of sub-standard seed. Viable seed and resultant increase in produce will encourage the farmers. Private Sector should be encouraged to enter into the field of Seed Production. For this they may be helped with provision of land, supply of pre-basic seed and entering into of contractual arrangements for purchase of their certified seed during the establishment phase of their operations.

i) Cultural Practices: Institutions that impart training need to be encouraged. Secondly, we need to develop visual training material. Thirdly, education programs can be run on Public Radio and TV.

j) Use of Stabilized Fertilizers/ Safe Pesticides: Advances in Research have revealed the viability of Stabilized and thus safe, mineral fertilizers. We need to adopt them forthwith. Despite ban on certain Pesticides, they are available in the market (Heptachlor etc.). Secondly, our Agricultural Department needs to be educated about modern and safe products. Once the concerned Authorities are convinced, the sale of unstabilized fertilizer can also be banned.

k) Fertilization: Again, this aspect can be practically demonstrated. Banding; deep banding and Foliar applications of fertilizers needs to be introduced. Training in this regard needs to be imparted. Not only does it result in great savings but also increases yields.

l) Plant Nutrition: We have much to learn about Plant Nutrition. The world has made great advances in this field. The latest techniques and methods should also be transferred.

m) Technical Support: The Agriculture Extension Service is badly in need of overhaul. One method is to encourage Private Technology Receiving & Transferring Centers.

n) Crop Insurance: Crop insurance through Community Based Associations will prove to be a positive step forward. In this manner, many mal-practices can be avoided and the livelihood of the small farmer can be protected.

o) Storage/ Cold Storage/ Proper Transport Facilities: At first sight, this problem seems to demand expensive remedies. Fortunately, there exists a Low Cost method of construction that will provide these facilities as far as storage is concerned. By-Products of this

[1] Biotechnology Global Update, Monsanto Pakistan AgriTech (Pvt.) Ltd. December 2000.

technology can be used for tiling drains; channels and canals. The technology is called Earth Sheltered; Ceramic Adobe; Passive Solar Construction.[1]

p) Rural Infrastructure. Pakistan has been paying a lot of attention towards the construction of Farm to Market roads. This needs even more emphasis in Mountainous Districts like Abbottabad. Provision of low-cost hydel electricity needs to be enhanced. Alternate means of energy like the promising passive solar turbines[2] or chemical fuel cells[3] needs basic research and development before we are left behind, perhaps irrevocably in this field as well.

q) Export: This factor can be resolved by opening up channels and avenues. Procedures can be simplified. Farming for export against orders needs to be examined. The concept of Export Houses can be considered.

r) Marketing Atmosphere: Not everyone is suited to marketing. Secondly, the poor and suppressed classes find it almost impossible to be aggressive in this regard. This and many other problems can be readily resolved by forming Farmers Communities. Many of the existing Community Based Organizations can be converted to this type of Organization. Specialists can be appointed to take on various Technical and Marketing aspects of Production. Imparting skills can also be facilitated by selection of persons with the requisite aptitudes. Tripartite association of Private Sector; Development Agencies and Communities is being examined and promises to yield good results in the future.

s) Information: Computer Technology should be used for Agriculture. The first step would be to prepare an Agri Data Base. All relevant information should be collected.

t) Expert Systems: Expert Systems can be deigned to retrieve information from the Data Base, as required, on a User Friendly basis.

u) Accredited Training: Training imparted in Technology Receiving & Transferring Centers can be Accredited to Institutions. The combination of Hands-On Training (HOT) and Formal Examinations should produce first class skilled workers. Diploma holders would be able to improve their employment chances both within and outside the Country.

v) Polymer Coated Seed: The quickest and least complicated method of achieving increase in the realization of the Genetic Potential of viable seed is by Treating them with safe Systemic Pesticides; Chelated Secondary and MicroNutrients and Natural Rooting and Fruiting Hormones registered and passed by the Environment Protection Authorities. These can then be protected on the seed with Polymer Coating (made using Urea as a Raw Material).

w) Provision of Agricultural & Horticultural Services: Employment of Technology Receiving & Transferring Centers Internees by provision of Agricultural and Horticultural Services to the surrounding populace can prove to be effective as well as generate funds to make the Technology Receiving & Transferring Centers self-sufficient.

x) Community Based Farmers and Marketing Associations: The extensive and growing CBO's Network can be made more effective by organizing them as Farmers Associations for growing crops and receiving Credit. Secondly, experts or individuals with aptitude can handle the Marketing of Produce and can receive specialized training in this regard.

y) Development Strategies: It is not possible to achieve sustainable development in any single sector, what to talk about as large and important a sector as agriculture, without taking

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1 Available with Khidmat Foundation.

2 Federal Republic of Germany.

3 United States.

into account the macro Economic Aspects of the National Economy. Secondly, the Institutional Framework through which policies are conceived, planned and implemented needs review. During the initial phases of an agricultural production boom there is a net flow of resources from the agricultural to the non-agricultural sector. This is primarily due to the size of the agricultural structure as well as the very necessity for development in the non-agricultural sector in order to enable demand to increase. Price policy and trade interventions on the part of the Government will determine resource transfer trends, their timing and intensity. Inter-sectoral transfers are effected, at any particular time, by three crucial considerations:

i. Is the quantity of transfer so large that it restrains the potential of agriculture to grow and generate more resources?
ii. Is there sufficient investment in agriculture to offset the negative effects of resource outflow?
iii. Is the transfer of resources from the agricultural to non-agricultural sectors actually stimulating growth in the sectors so as to sustain a healthy growth in demand for agricultural inputs?[1]

z) Fiscal Policies: Balance between decreasing cost of production and taxation of value output of agricultural produce must be maintained. Cost of production is reduced by:

i. Construction of all-weather roads to link all villages with urban centers.
ii. Universal electrification of rural areas.
iii. Universal and progressive education throughout all rural areas.
iv. First class adaptive and applied, research and development in agriculture.
v. High class and effective agriculture extension.
vi. Effective Grass-Roots Farm Organizations.
vii. Installation of Small and Medium Scale, labor intensive industry in rural areas.

Taxation of value output of agricultural produce can take many forms:

i. Direct Land taxes.
ii. Compulsory procurement of agricultural commodities to depress prices.
iii. Investment of farm income into small and medium industry.

aa) Value Addition; To overcome the problems of surpluses and losses in high value crops, there is a need for the establishment of value added processing of agricultural produce. This is possible even in the major and minor agricultural crops. For instance the production of wheat bran and whole wheat bread, processing of maize into glucose, rice cereals and baby food, canning of peas and beans etc.

bb) Structural Reforms: The present Patwar System is a holdover from an ancient past. It is imperative that this be changed. This measure is of Primary Importance and is discussed in detailed in the following section.

6. PATWAR SYSTEM:

6.1 Introduction: A close scrutiny of our entire Land Record and Revenue System will reveal a Pandora's Box of wrong and injustice. This major problem has to be faced and corrected on a priority basis! It is no service to our Society to behave like the proverbial ostrich and hide our heads in the sand. Is this problem so basic? You might well ask. I propose to prove it to be a major source of evil and a stumbling block on the path to progress.

[1] Prime Minister's Task Force on Agriculture, 1993.

6.2 Hurdle: The prevalent Patwar System is the very basis that prevents progress and leads to corruption for the following reasons:

6.2.1 Litigation: Prevalence of long running litigation between various claimants of land leading to:

a) Blood Feuds.
b) Waste of valuable time and money in pursuing cases.
c) Over loading of the Judicial System.
d) Justice delayed and denied due to corruption.
e) Cause of deprivation, frustration and disillusionment.
f) Mine of corruption.

6.3 Fraud: Misappropriation of Public and Private Lands due to active connivance and participation of Land Record Staff, taking advantage of confusion in records.

6.4 Revenue Loss: Siphoning off of Government Revenue leading to colossal losses.

6.5 Economic Loss: Inequitable distribution of land and uneconomical holdings, leading to non-utilization of land to its true potential.

6.6 Black Money: Use of land as a cover for black money and ill gotten gains as records are not easily checked.

6.7 Poor Planning: Impossible to effectively plan and use land for maximum advantage in both rural and urban areas leading to:

6.7.1 Congestion.
6.7.2 Pollution.
6.7.3 Waste.
6.7.4 Lowering of Quality of Life.
6.7.5 Progressive degeneration, due to bad, or absent long-term planning.
6.7.6 Improper planting and raising of crops leading to deficiencies and resulting in expensive imports.
6.7.7 Setting of bad example to coming generations.

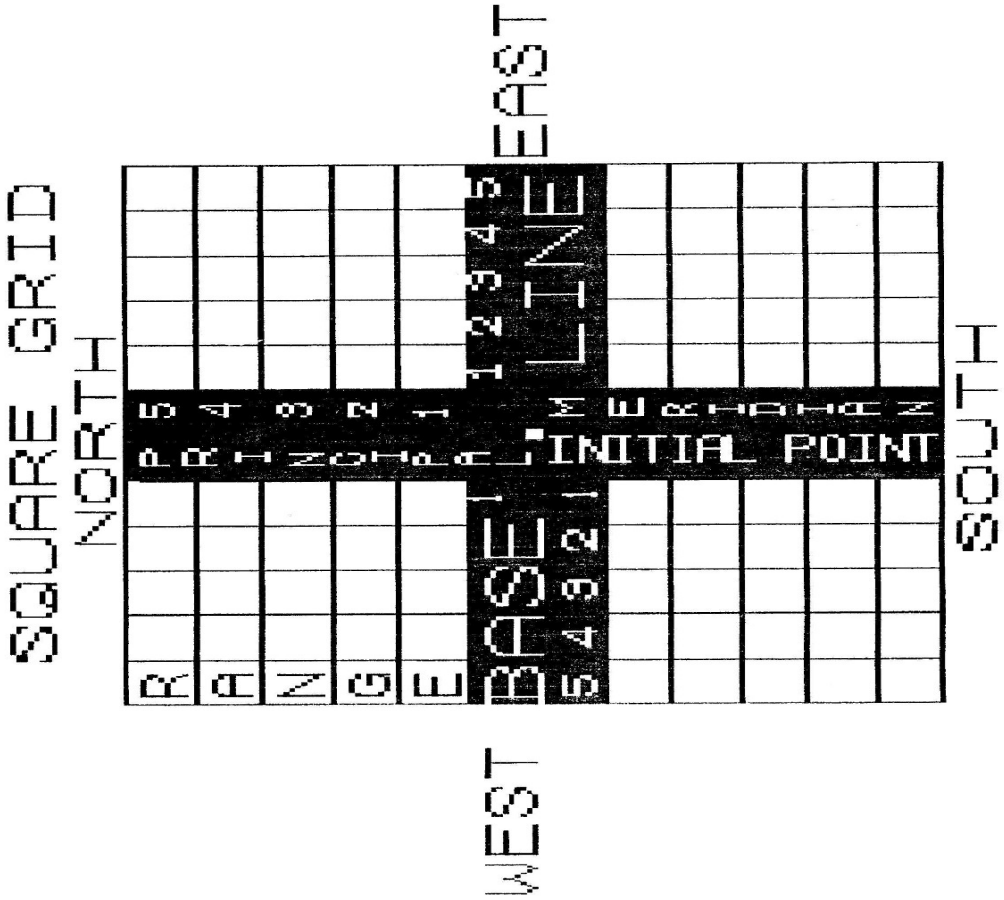
6.8 Requirement: From the foregoing, it should be more than obvious that this problem is both serious as well as of fundamental importance to all future planning and implementation. Thus efforts are required to correct the system immediately. The following measures are advocated:

6.8.1 Complete Satellite Survey.
6.8.2 3-D Color Negative Aerial Photography.
6.8.3 Survey for, and preparation of, 20 cm to I Km scale plan maps**.**
6.8.4 Computerization of Records and Maps.

6. 9 The map: The basic of map making is the Grid System. The Modern Universal Metric System should be adopted right down to Marlas and even below. Quite obviously a 1-cm: 20m map would actually represent a plan. Every field can be denoted to square meters. Detailed scale down to true width of roads and streams can be accurately depicted. The first step is to establish an initial Point, the longitude and latitude of which is known. Then, a True North and South line called a “Principal Meridian” is run through the Initial Point and marked on the ground. Next a line is run East and West from the Initial Point. This is called a “Base Line” and is perpendicular to the Principal Meridian. On either side of the Principal Meridian land is laid out in approximately square units of 5-Km square. Each “Square” is divided into 25

"Sections" approximately I Km square. Each Section can be further sub divided right down to square meters if so required. Each Square thus contains Sections numbered I to 25 starting in the North East corner and moving alternately left to right then right to left, ending in the South East Section. A Tier of Squares is called a "Range". Thus each Section can be located by its Number, Square and Range. The Squares being described as so and so Squares, North or South of a named Base Line and so and so Squares, East or West of a named Principal Meridian. Sections may be further sub divided into "Quarters" and identified by its compass direction - NE; SE; SW; NW. The corners of each Section and Quarter Section can be permanently located on ground by building small monuments. The exact location of the corner is stamped into a brass cap on top of the monument.

Figure 3: The Grid System:



5	4	3	2	1
6	7	8	9	10
15	14	13	12	11
16	17	18	19	20
25	24	23	22	21

<table>
<tr><td>NW I/4
NW I/4</td><td>NE I/4
NW I/4</td><td>NORTH
QUARTER</td><td>EAST</td></tr>
<tr><td>SW I/4
NW I/4</td><td>SE I/4
NW I/4</td><td colspan="2" rowspan="2">NE 1/4</td></tr>
<tr><td colspan="2">N 1/2 SW 1/4</td></tr>
<tr><td colspan="2"></td><td>WEST HALF OF SOUTH EAST QUARTER</td><td>E 1/2
SE 1/4</td></tr>
</table>

Figure 4: Locating on the Grid System:

6.10 Justification: Quite evidently this massive exercise would be-quite expensive to undertake and Staff. In order to justify the expense, I would point out that after Computerization of Land Records and adjustments as in "Jumah Bandi", obviously disputes will arise and should be immediately and impartially settled on a priority basis. Secondly, existing Staff will no longer be relevant as Computer Operators would have to be inducted and trained. With roaster records and duplication, fraud will be eliminated and much land recovered from the corrupt. Sale of these lands and recovery of Government Lands will yield massive returns. It is reasonably safe to assume that lands now held by the very Staff engaged to keep records will alone suffice to more than pay for the exercise. These funds generated can be used to reimburse the expenses incurred. Thirdly let us look at the disciplines that would use the information gained and present further spin offs;

6.10.1 Planning & Development.
6.10.2 Soil Conservation.
6.10.3 Agriculture.
6.10.4 Forestry.
6.10.5 Fishery.
6.10.6 Wildlife Management.
6.10.7 Geology.
6.10.8 Mining.
6.10.9 Natural Resources utilization.
6.10.10 Geography.
6.10.11 Civil Engineering.
6.10.12 Civil Defense.
6.10.13 Military Defense.
6.10.14 Flood Control/ Natural Calamities Management.
6.10.15 Industry.
6.10.16 Land Record/ Revenue.
6.10.17 Population Welfare.
6.10.18 Election Authority.
6.10.19 Irrigation.
6.10.20 Environment Protection.
6.10.21 Financial Institutions.
6.10.22 Trade and Commerce.
6.10.23 Meteorological Departments.

6.11 To be more specific let us enlist some of the practical uses:

6.11.1 Study of Wind Action/ Erosion.
6.11.2 Ground Water Surveys.
6.11.3 Mass movements.
6.11.4 Glaciers Study.
6.11.5 Watershed Management.
6.11.6 Desert Control.
6.11.7 Water Erosion and erosion cycles.
6.11.8 Lithology (discrimination of rock types).
6.11.9 Rock Structures.
6.11.10 Vegetation.

6.11.11 Soils.
6.11.12 Rural/ Urban Planning.
6.11.13 Communications (Roads, rail, water, phone etc.).
6.11.14 Forest measurement, plantation, and fire control.
6.11.15 Land Use & Land Capability Maps.
6.11.16 Crops planting, pest controls.
6.11.17 Land Revenue assessment.
6.11.18 Land sale/ purchase.
6.11.19 Long Term Planning.
6.11.20 Civil/ Military defense planning.
6.11.21 Mineral/ 0il/ Gas exploitation.
6.11.22 Irrigation.
6.11.23 Drainage.
6.11.24 Electricity provision.
6.11.25 Election exercise.
6.11.26 Census Operations.
6.11.27 Export of harvests and yield.
6.11.28 Mortgage of lands for projects.
6.11.29 Weather forecasting and effects.

6.12 Method: The cadre recruited, as mentioned in the introduction, would be utilized both for initial survey and subsequently for manning the new posts created. Due to the fact that the National Census has been carried out, this exercise can be carried out as a Post Census exercise. Secondly it appears that many Foreign Agencies have funded and even carried out exercises that should be collected and used for these purposes. For example surveys carried out by Oil Exploration and Drilling Companies and Detailed Soil Surveys of the Geological Survey of Pakistan, presently classified as restricted. These, and other data, lying unused in various Government Departments, should all be collected in one place and proper use be made of them. Additionally, these reports and the fruits of the labor of the subject under discussion should be available to the Public so that economic possibilities may be examined and pursued. This exercise can be carried out under the Administrative Support of the Pakistan Army.

6.13. Existing Structure: The present system, run from the Deputy Commissioners office, consists of a chain headed by the Tehsildar, followed by a Naib Tehsildar; Gardawar/ Qanungo and finally the Patwari. Records are kept on Cotton sheets and the system dates back to the times of Todar Mal in the reign of the Emperor Akbar. Usually the Patwari is employed on "Sifarish" from the powers that be in the districts. The characteristics of these functionaries is proverbial and there is no necessity to recount them. However it is a fact that they have enriched themselves considerably at the expense of the Exchequer and the general Public. This exploitive and corrupt system has to be eliminated immediately, if there is any hope for progress. There is no question of window dressing. The exercise has to be complete. The powers of the new structure have to be curtailed to exclude the all-encompassing purview of the present incumbents. These powers have taken up the posture of rulers and petty despots. The duties of the Patwari are as follows:

6.13.1 Maintains Record of Land Ownership.

6.13.2 Effects Transfer and mutation of Land.

6.13.3 Maintains Record of Mortgage and alienation of Land.

6.13.4 Estimates value of crops for Revenue purposes.

6.13.5 Assesses damage from Natural calamities.

6.13.6 Channel for Relief measures.

6.13.7 Channel for Government Subsidized Crop purchase.

6.13.8 Maintains Record of Government Land and Lease.

6.13.9 Aids Election/ Census/ Flood Relief Authorities.

6.13.10 Channel for collection of "Abiana" and "Ushr".

6.14 Suggested Structure: It is suggested that there should be a division of work wherein Maintenance of Record be retained with the DCs office and assessment and collection be transferred to elected representatives at Village and Mohallah level. The reason for this is that once any transaction or change is effected in the status of land, it should be given a computer number and date. This date should be automatically entered in records and Updating and Compliance Report be completed within a stipulated time frame. In case there is any delay there should be an inquiry and those responsible be taken to task. This function should be totally clerical and no power of delay or blackmail be afforded to the personnel responsible. Weekly reviews of the Record be made and Monthly Reports be submitted to higher Authorities. Periodical checks and Management Audits be carried out to ensure that work is being done in accordance to the laid down rules and procedures. In so far as assessment and collection is concerned, it will be greatly facilitated by the separate records and a permanent check will be maintained. Elected representatives will perforce comply with rules of justice and equity in the fear of losing votes. They will be unable to extend undue favor by the check of established targets held in the records. In the case of unholy alliances between the Records and Collection Agencies, the Management Audit will play its due role. Political Opposition and Social Welfare Organizations should be adjusted in this role. Computer search programs can detect misappropriation practices.

7. WHEAT:

7.1 This crop represents the staple diet of the region. It is therefore essential to know about its growth stages and requirements for nutrition. Our Fertilizer recommendations are out of date by about 20 years. At present we are recommending only the following:

7.1.1	Urea	2 bags (100 Kgs.). Split Application. 46 Kgs. N.
7.1.2	Diammonium Phosphate	1 bag (50 Kgs.). 27 Kgs. P +10.5 Kgs. N.
		N: 56.5 Kgs.
		P: 27 Kgs.

7.2 This is incorrect. As can be seen, from the figure that follows, the wheat plant requires a balanced Macro Nutrient supply.

7.2.1	Nitrogen	48 Kgs.
7.2.2	Phosphorus	21 Kgs.
7.2.3	Potassium	34 Kgs.

7.3 It is not possible for the plant to extract its required amount of nutrition from the recommended fertilizers. Secondly, both the fertilizers recommended either contain Nitrate Nitrogen or rapidly destabilize to that form. Stabilized Ammonium or Amide Nitrogen is recommended to avoid leaching of Nitrates into the ground water as is already the case in the Rural areas of Abbottabad District. A more realistic and cost effective Fertilizer regime is:

7.3.1 Sulfur coated Urea -2 bags (90 Kgs.) Split Application. 41.4 Kgs. N.
7.3.2 Monoammonium Phosphate -1 bag (35 Kgs.). 21.7 Kgs. P + 4.2 Kgs. N.
7.3.3 Muriate of Potash 1 bag (50 Kgs.). 32.5 Kgs. K.

N: 45.6 Kgs.
P: 21.7 Kgs.
K: 32.5 Kgs.

7.4 Since these are not available in the market the following is recommended along with heavy manuring/ composting:

7.4.1 Urea -2 bags (100 Kgs.) Split & Foliar 41.4 Kgs. N
7.4.2 Triple Super Phosphate 1 bag (50 Kgs) 16.5 Kgs P.
7.4.3 Sulfate of Potash 1 bag (50 Kgs) 26 Kgs K.

N: 41.4 Kgs.
P: 16.5 Kgs.
K: 26 Kgs.

Secondly, seed treatment with 2mL Natural Rooting & Fruiting Hormones and 4 mL of Chelated Zinc per Kg seed will ensure a plentiful harvest. It is also important to plant at least 50 to 60 Kgs seed per acre or 400 plants per square yard. A follow up of Chelated Zinc and Magnesium is sprayed along with the second application of Nitrogen in early spring.

7.5 Natural Rooting & Fruiting Hormones:

Active Ingredients: Cytokinins, Gibberellic acid and Indole-3-butyric acid.

The effects of this product upon Wheat is as follows:

7.5.1 Massive roots specifically downwards, leading to drought resistance.
7.5.2 Shorter plant, no lodging problems.
7.5.3 Plant stays green longer.
7.5.4 Less disease.
7.5.5 High yields due to increased tillering and uniform bearing on each tiller.
7.5.6 Increased Stress resistance.
7.5.6 Increased vigor.

7.6 Zinc chelated with Polyphenolic acid complexing agent.

Active Ingredients: Zinc 20 %, Sulfur 15 %.

The Wheat plants, as a part of their nutrition require both Zinc and Sulfur.

7.7 The present recommendation has been tried on Wheat in a number of locations in different parts of the Country. It has resulted in more drought resistance (deep rooting due to rooting hormones and zinc) as well as an increased harvest from 30 to 50 % of former yields (depending upon irrigation/ rainfall).[1]

7.8 To overcome obvious deficiencies in applied nutrient quantities it is recommended that foliar applications be made. It has been demonstrated that Foliar Nitrogen is 50 % more efficient than soil applied Nitrogen. Also Ammonium form of Nitrogen present in Urea is absorbed and utilized before it has a chance to destabilize into Nitrate Nitrogen. However, it is important to note the amount of Urea that can be sprayed onto a plant without causing leaf burn. Secondly, as Triple Super Phosphate is not soluble in water it is not possible to spray this nutrient. It is safe to broadcast TSP. A total of 50 % of Nitrogen is absorbed within half an hour to 2 hours. It takes 10 to 24 hours for 50 % Potassium to be absorbed. Zinc is 50 % absorbed in 1 to 2 days. Urea

[1] Khidmat Foundation: Bucheke, District Sheikhupura, Punjab – 1997. Daharki, District Ghothki, Sindh – 1998. Babraki, District Attock, Punjab – 1999. Mung, District Haripur, NWFP – 2000.

should be used at the rate of 10 grams per Liter of water. Foliar Application is recommended at 200 Liters of water for 1 acre or 2 Kgs Urea per spray.

7.9 Wheat Plant Food Breakdown[1].

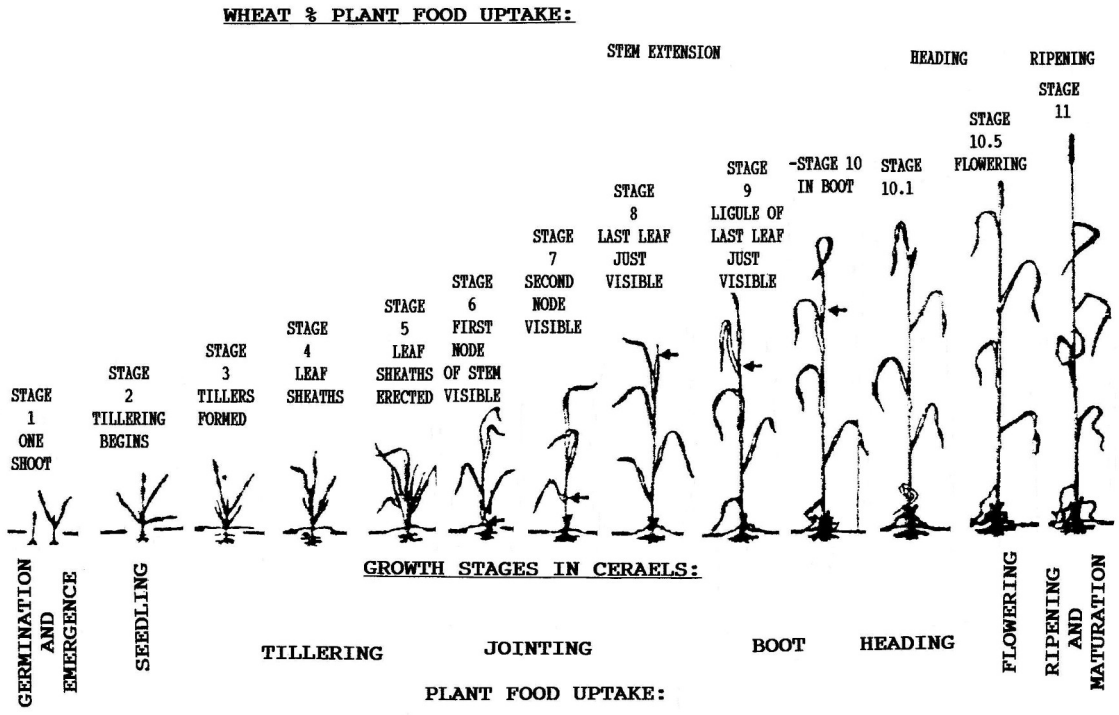


Figure 5: Growth Stages in Cereals:

Table 16: Wheat Percent Plant Food Uptake:

Nutrient	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
N	1.9	16.8 (18.7)	48.9 (67.6)	32.4 (100.00)
P2O5	1.4	12.9 (14.3)	43.1 (57.4)	42.6 (100.00)
K2O	1.0	11.7 (12.7)	41.9 (54.6)	45.4 (100.00)

1st Quarter: Germination/ Emergence & Seedling Stage.
2nd Quarter: Tillering.
3rd Quarter: Jointing.
4th Quarter: Boot & Heading till Flowering, Ripening and Maturation.

7.10 Wheat Calendar:

7.10.1 October (After Maize Harvest):

a). Carry out land leveling.
b). Introduce Compost/ well rotted farm yard manure 1.5 trolleys per kanal.
c). One pass Rotavator, two passes cultivator.
d). Select Seed from Certified Stock (65 Kgs. per acre).
   i. Barani (Rainfed):
      aa. Inqilab 91 F-II (25 Oct – 10 Dec).
      bb. Sulaiman 96 (25 Oct – 15 Nov).
      cc. Nowshera 96 (01 Nov – 20 Nov).
      dd. Tatara (25 Oct – 15 Nov).

[1] Stoller Pakistan (Pvt.) Ltd.

ii. Irrigated:
aa. Bakhtawar 92 (01 Nov – 20 Nov).
bb. Khaiber 87 (01 Nov – 15 Dec, Late variety).

e). If possible apply EPA Registered Pre-Emergence Herbicide mixed with Natural Oil Surfactant (750 mL Herbicide/ 250 mL Natural Oil).

f). If possible apply Bio-Post 0.5 to 1 bag per kanal.

g). Apply selected/ available fertilizer through drill at the rate of 2 % N, 100 % P (If liquid P2O5 not available, if available apply 1.5 % granulated P) and 1 % K.

h). Soak seed in 25 L water with 130 mL Natural Hormones & 500 mL Chelated Zinc for 12 hours before planting. Dry in shade, seed by drill.

7.10.2 November:

a). Continue planting as per selected seed/ type of agriculture (Rainfed/ Irrigated).

7.10.3 December:

a). Culminate planting as per selected seed/ type of agriculture (Rainfed/ Irrigated).

b). Use post-emergence (safe & registered) herbicide with Natural oil surfactant if pre-emergence not used OR weed by hand.

c). At 2 – 3 blade stage apply as foliar spray: 17 % N, 13 % P (if liquid P2O5 available) and 12 % K.

7.10.4 January:

a). Continue weeding if using physical means.

7.10.5 February:

a). When flag leaf is visible apply 49 % N, 43 % P (liquid P2O5) and 42 % K as foliar spray.

b). Continue weeding if using physical means.

c). In case of rodent attack use preventive measures (traps/ chemical).

7.10.6 March:

a). Continue weeding if using physical means.

b). Apply remaining fertilizer as foliar spray: 32 % N, 42.5 % P (liquid P2O5) and 45 % K.

c). Continue rodent protection.

7.10.7 April:

a). Continue weeding if using physical means.

7.10.8 May:

a). In warmer areas of the District harvesting can commence. Ensure 15 to 20 % moisture in grain at harvest by physical means (crop is ripe enough to harvest 30 days after flowering).

b). Place gunny bags in boiling water for 5 minutes. Ensure all cracks/ openings in grain stores are sealed. Clean thoroughly before storing grain.

c). In case of inclement weather, harvest grain and tie in bundles. Allow complete drying before threshing.

7.10.9 June:

a). Complete harvesting/ threshing.

7.10.10 July to October:

a). Inspect stored grain every 15 to 20 days for pest attack. Protect accordingly.

8. MAIZE:

At one time Hazara Division was famed for the quality of Maize that was produced. Now a days, the quality of seed and level of yields have deteriorated to such an extent that the crop is almost not worth the effort. It is extremely important to develop new seed and ensure proper fertilization for this crop. The Stover of this crop provides the main source of cattle feed in Winter. Secondly, the flour of Maize is also used extensively as food for the local populace. Maize can be treated similarly to wheat as far fertilization is concerned. Although Maize has a much greater requirement for nutrients as compared with wheat. However, to remain cost effective it is recommended to stay within the fertilizer regime of wheat. It is also important to obtain good seed for planting.

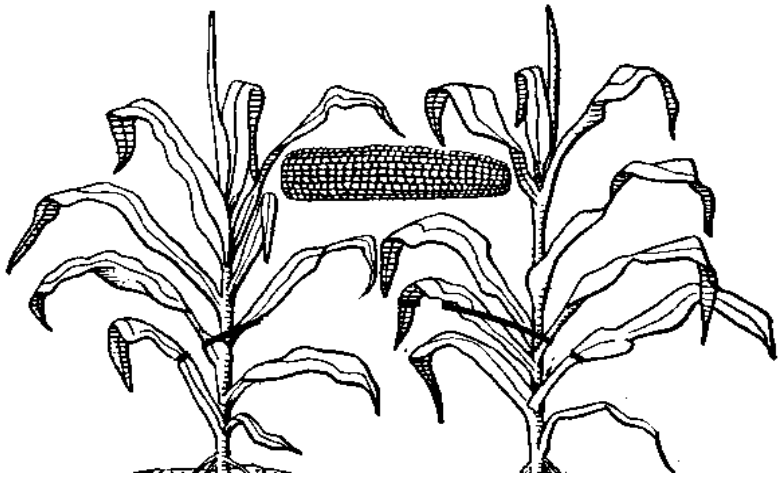


Figure 6: The Maize Plant.

7.1 It will be observed that with the use of Natural Rooting and Fruiting Hormones, Potassium, Zinc and Magnesium there will be reduced lodging, thicker stems, increased tillering, increased fruiting and uniform grain on the cob.

7.2 Corn Plant Food Uptake Breakdown[1].

Table 17: Corn Percent Plant Food Uptake:

Nutrient	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Dry Down
N	8	34 (42)	31 (73)	20 (93)	7 (100)
P2O5	4	27 (31)	36 (67)	25 (92)	8 (100)
K2O	9	44 (53)	31 (84)	14 (98)	2 (100)
Days From Emergence					
100 day	22	44	66	End of 3rd Quarter: 50 % Silking or Pollination	
120 day	26	52	79		

Table 18: Nutrient Uptake per day by Growth Periods in Corn:

Sampling Stage	Days in Period	Nutrient Uptake Per Day (Kg)		
		N	P2O5	K2O
4 - Leaf	32	0.38	0.08	0.58
8 - Leaf	12	1.63	0.35	3.35
12 – Leaf	15	3.43	0.90	3.37
Early Tassel	13	11.05	2.85	15.32

[1] Stoller Pakistan (Pvt.) Ltd.

Silk	12	-1.43	0.88	2.63
Blister	18	1.00	0.70	0.68
Early Dent	31	3.71	1.44	1.41
Mature	13	0.16	1.16	-1.65
Total	146	19.93	8.36	25.69

7.3 Maize Calendar:

7.3.1 July (After Wheat Harvest/ May or June for Single Crop Higher Elevations of Galliat):

a). Carry out land leveling.
b). Introduce Compost/ well rotted farm yard manure 1.5 trolleys per kanal.
c). One pass Rotavator, two passes cultivator.
d). Select Seed from Certified Stock (4,000 seed per kanal).
e). If possible apply EPA Registered Pre-Emergence Herbicide mixed with Natural Oil Surfactant (750 mL Herbicide/ 250 mL Natural Oil).
f). If possible apply Bio-Post 0.5 to 1 bag per kanal.
g). Apply selected/ available fertilizer through drill at the rate of 8 % N, 100 % P (If liquid P2O5 not available, if available apply 4 % granulated P) and 9 % K.
h). Soak seed in 25 L water with 125 mL Natural Hormones & 500 mL Chelated Zinc for a few minutes before planting. Dry in shade, seed by drill.

7.3.2 August:

a). Culminate planting by 1st week as per selected seed/ type of agriculture (Rainfed/ Irrigated).
b). Ensure 6 to 9 inches inter plant distance. Cultivate if plants are 25 to 30 days old.
c). Spray with Zinc & Sulfur compound to protect against pest attack and promote growth. Use 0.5 Kgs WP in 200 L water per acre.
d). Apply as foliar spray: 34 % N, 27 % P (if liquid P2O5 available) and 44 % K.
e). Use post-emergence (safe & registered) herbicide with Natural oil surfactant if pre-emergence not used OR weed by hand.

7.3.3 September:

a). Apply remaining fertilizer as foliar spray: 58 % N, 69 % P (if liquid P2O5 available) and 47 % K.

7.3.4 October:

a). Harvest when grain is hard.

7.3.5 November to July:

a). Inspect stored grain every 15 to 20 days for pest attack. Protect accordingly.

8. RICE:

The current state of R&D in Hill or Mountain Rice varieties, is lamentable. All emphasis has been placed on the rice varieties of the Plains. Abbottabad District, like some of the adjoining Districts, grows some hill or rough rice. This is sufficient reason for research in these varieties.

8.1 Some of the genetic characteristics that should be developed are:[1]

8.1.1 Dwarfed and in possession of stiff straw to reduce lodging.

8.1.2 Short duration and early maturation to enable multiple cropping.

[1] Rice, Production, Productivity and Research Management, D.K. Desai, Madalsa Gandhi, Indian Institute of Management, Ahmadabad, 1988.

8.1.3 Profuse tillering and simultaneous tiller development.
8.1.4 Fertilizer responsive.
8.1.5 Possess narrow, stiff and upright leaves, enabling efficient utilization of solar radiation and consequent increased photosynthetic activity.
8.1.6 Not sensitive to photoperiods to enable growing in most seasons.
8.1.7 Seed should not remain dormant after harvest in order to enable immediate re-planting.
8.1.8 Superior yield increasing characteristics like:
a) Higher number of effective tillers per crownhill.
b) Heavier grain.
c) Higher number of grain per panicle.

8.2 At present Abbottabad District's rice yields are 1,261 Kgs per hectare or 504.4 Kgs per acre (12.61 maunds/ acre). Trials on rice in the plains (Bucheke, Punjab[1]), yielded 40 maunds/ acre with Agricultue Department fertilizer recommendations and 60 maunds per acre with Stoller Pakistan Ltd. recommendations and Nutrients/ Compounds. This 28.5 % increase in yield if duplicated in Abbottabad District would mean a yield of 16.21 maunds/ acre or 648 Kgs/ acre. At present the total production of rice in Abbottabad District is 58 tons on 46 hectares. A 28.5 % increase would enable yield of 74.53 tons (increase of 16.43 tons). The recommended Nutrition program is:

8.2.1 Seed Treatment:
a) Rooting & Fruiting Hormones: 100 mL per 45 Kgs seed.
b) Chelated Zinc: 500 mL per 45 Kgs seed.

8.2.2 Macro Nutrients:
a) Ammonium Sulfate: 50 Kgs. at transplanting and 50 Kgs. 45 days later.
b) Triple Super Phosphate: 50 Kgs. at transplanting.
c) Potassium Chloride: 50 Kgs at transplanting.

8.2.3 MicroNutrients:
a) Chelated Zinc: 1 L when plants are 3 weeks old.
b) Balanced MicroNutrients; 500 mL as foliar spray on panicle initiation.
c) Calcium & Boron: 400 mL as foliar spray on panicle initiation.

8.2.4 Compounds:
a) Rooting & Fruiting Hormones 100 mL 2 weeks after transplanting, 100 mL at panicle initiation.

8.3 Nutrients Deficiency Guide[2]:

8.3.1 Nitrogen: Old leaves become yellow from the tip down to the base and then dry up. Plants bear a slow growth, low leaf formation and thin stalks.

8.3.2 Phosphorus: Older leaves bear bronze-like color at the tips, turning into yellow-orange color from the tip down to the base of the leaf, then dry up all the way to the stem. New leaves bear a darker green color. Leaf formation is reduced and stems are thin.

8.3.3 Potassium: A white cholorisis begins at the tip of old leaves, progressing at the borders and followed by a necrosis of these sites on the leaf which then curl upwards. The plants become stunted.

8.3.4 Zinc: New leaves bearing a green-whitish chlorosis, on each side of the main vein, extending towards the tip. Older leaves bear longitudinal rust colored spots.

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1 Khidmat Foundation, 1998.
2 Stoller Pakistan Ltd.

There is a reduction in growth and leaf formation, short internodes and a late ripening.

8.3.5 Boron: Plants bear a small growth. New leaves and buds, under a more severe deficiency, appear more whitish and may die.

8.3.6 Iron: New leaves bear an intervenous chlorosis, which may progress and turn into a complete yellow leaf.

8.3.7 Calcium: New leaves have yellowing borders. Small wrinkling on the leaf border may occur. The leaf tips usually bear a brown color and are distinctly more curled up, giving a drought-like appearance. There is root growth restriction.

8.3.8 Magnesium: Older leaves bear a yellow-brownish intervenous chlorosis. At a more severe stage, these leaves curl up inwardly quite similar to a strong water stress.

8.3.9 Sulfur: The deficiency symptoms are similar to the ones found in Nitrogen deficiency (a uniform yellowing of the interveinal area), in the case of Sulfur deficiency, the symptoms appear first on new leaves. Plant growth is slowed down.

8.3.10 Manganese: Begins with an intervenous chlorosis of new leaves followed by the appearance of small grey spots, which necrose. The new leaves are short and narrow.

8.3.11 Copper: New leaves bear a green-bluish color, developing a chlorosis at the tips and progressing down on each side of the main vein. These leaves curl up and the tips necrose. There is also an inhibited growth.

8.3.12 Molybdenum: There is little incidence of visual manifestation of molybdenum deficiency. However, low nutrient levels in tissues affect the plant's absorption of Nitrogen. Older leaves may have necrotic spots.

9. LEGUMES:

Legumes are considered as the most important crops in the world. This is due to the fact that they are rich in proteins and high in bone building minerals and vitamins. Legumes can obtain Nitrogen from the Air. The air consists of 80 % Nitrogen. Legumes work symbiotically with special bacteria (rhizobia) to obtain this Nitrogen. Rhizobia infect the root hairs of leguminous plants. This results in the development of nodes or nodules. The pure Nitrogen of the air is not only fixed through these nodules, it is also left over for subsequent crops. It is estimated that leguminous plats fix 80 million tons of Nitrogen annually. Crop legumes fix about 35 million and legumes in meadows, grasslands and forests account for the remaining 45 million tons. In many soils the nodule bacteria is not adequate, either in number or quality. Thus it becomes necessary to inoculate the seed of legumes or the soil with rhizobia cultures. With seed inoculation, rate is recommended at 4 to 6 grams per Kg. In the case of soil granular inoculant, 6 to 8 Kgs per Hectare are required. We are concerned presently with the Mung Bean which is grown on only 5 Hectares of land in Abbottabad District. Post monsoon peas, winter, seed peas and snow peas can also be grown. Probably due to low yields these plants are not given the importance that is due. Cultivation of these crops can be greatly increased to provide Nitrogen fixing capacity to the soil, as well as for nutritious value. Nodule Bacteria (Rhizobium spp.) are cultured in a laboratory and combined with a suitable carrier material. Graphite is available in many parts of Hazara Division (Kaghan) and further evaluation is needed for availability and

quality in Abbottabad District. It is a well recognized fact that a large number of viable effective rhizobia are required to inoculate legumes successfully. Rhizobia are living one-celled bacteria. Insufficient moisture or high temperatures (40 ° C) will kill them.

Inoculation is needed whenever new leguminous crops are introduced. Also many soils are heavily infested with ineffective rhizobia capable of inducing nodulation without host benefit. In this case a heavy dose of inoculum of competitive and highly effective strains of rhizobia is needed to counteract the aggressive native rhizobia. When it is not known about the state of rhizobia in the soil a filed test is used.

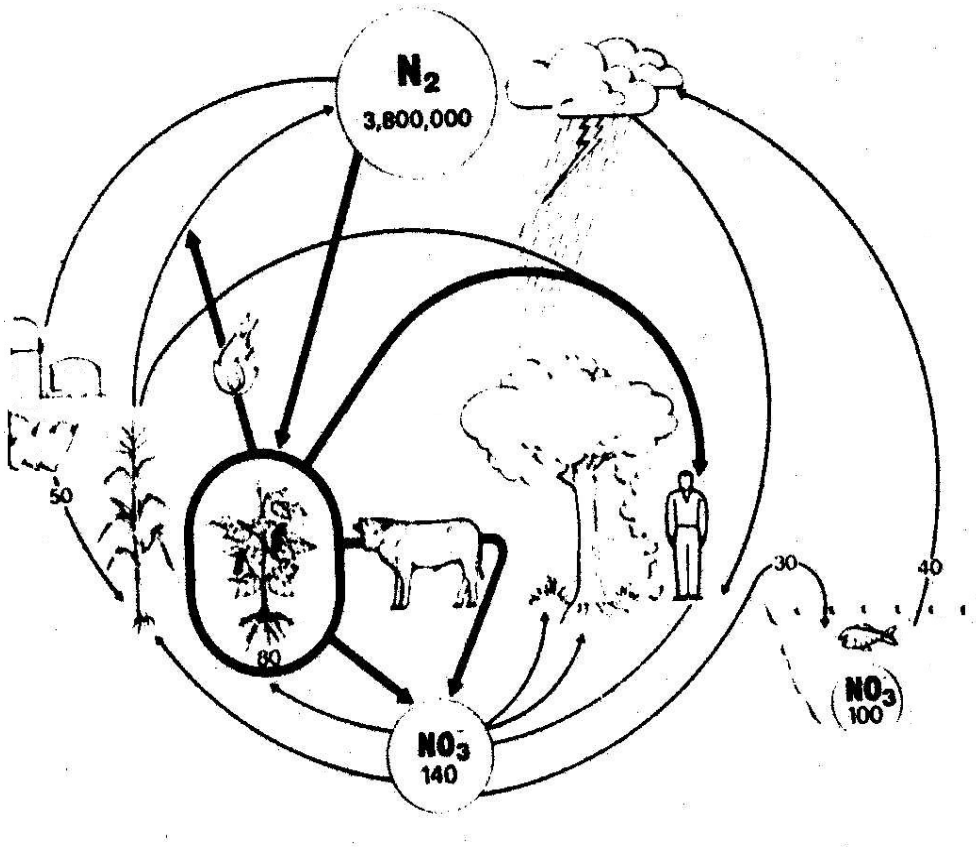

Figure 7[1]: Nitrogen Schematic Pathway:

9.1 Field Test: Here three basic treatments are needed:

9.1.1 Inoculated plants from seeds inoculated with the best inoculant available.

9.1.2 Non-inoculated plants receiving no fertilizer treatment.

9.1.3 Non-inoculated plants furnished with Nitrogen fertilizer (to serve as a test for growth conditions).

[1] Legumes & Inoculations, courtesy NARC.

It is recommended that these three treatments should be made at two fertility levels. One that is normally used by the farmer and one that is the optimum level from an economic viewpoint. Four replications of each treatment, in randomized plots, are recommended.

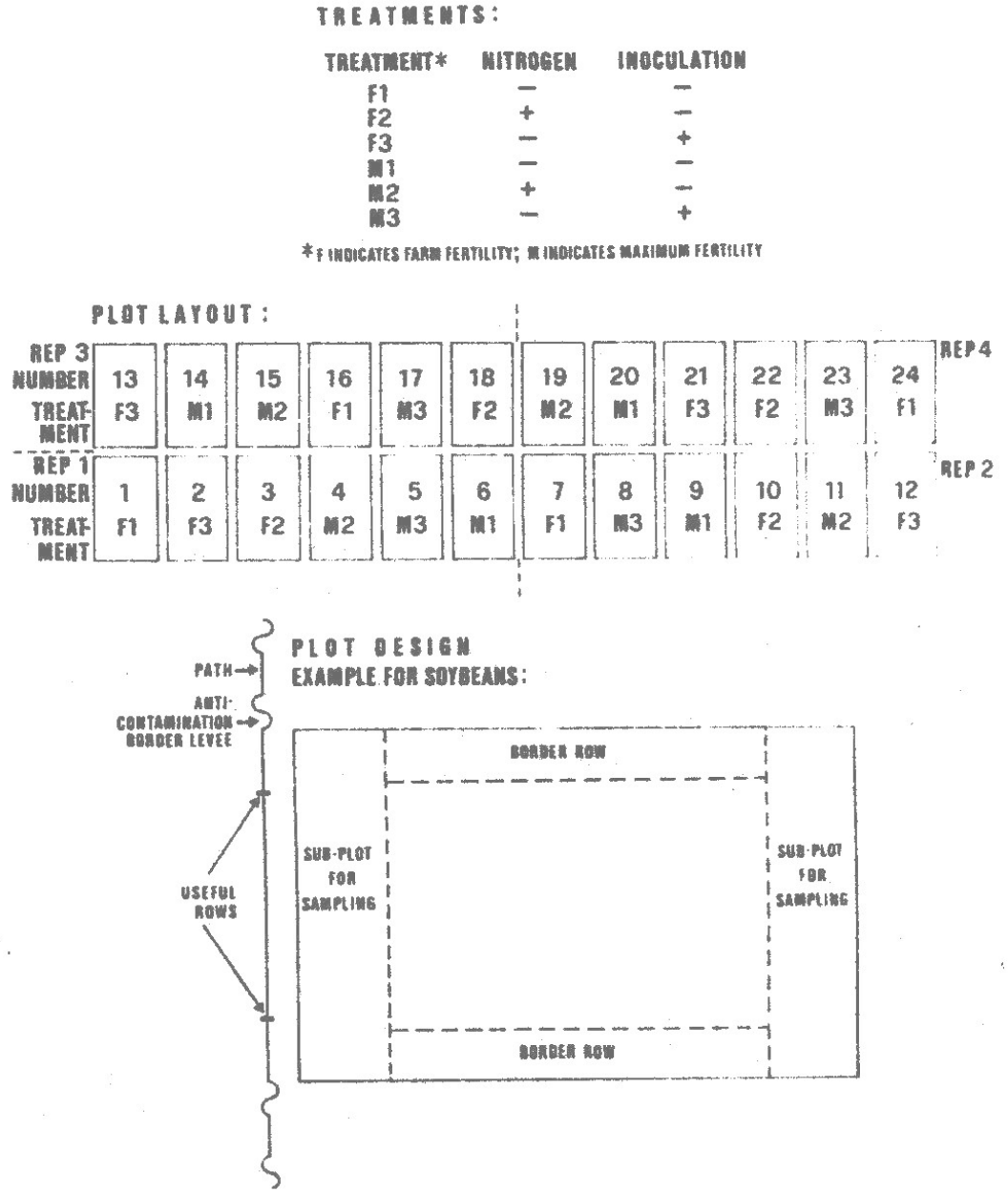
TREATMENTS:
TREATMENT* NITROGEN INOCULATION
F1 – –
F2 + –
F3 – +
M1 – –
M2 + –
M3 – +
*F INDICATES FARM FERTILITY; M INDICATES MAXIMUM FERTILITY
PLOT LAYOUT:
REP 3
NUMBER 13 14 15 16 17 18 19 20 21 22 23 24
TREAT-MENT F3 M1 M2 F1 M3 F2 M2 M1 F3 F2 M3 F1
REP 4
REP 1
NUMBER 1 2 3 4 5 6 7 8 9 10 11 12
TREAT-MENT F1 F3 F2 M2 M3 M1 F1 M3 M1 F2 M2 F3
REP 2
PLOT DESIGN
EXAMPLE FOR SOYBEANS:
PATH
ANTI-CONTAMINATION BORDER LEVEE
USEFUL ROWS
BORDER ROW
SUB-PLOT FOR SAMPLING
SUB-PLOT FOR SAMPLING
BORDER ROW

Figure 8[1]: Field test for Rhizobium.

[1] Legumes & Inoculations, courtesy NARC.

Table 19: Field Situations found in Inoculation Trials[1]:

Sr	Situation	Explanation
	Non-inoculated Plants.	
1	No nodules on non-inoculated control. Plants yellow.	No native rhizobia capable of infecting that legume.
2	Many small nodules scattered over root system. Plants yellow.	Native rhizobia are ineffective in fixing nitrogen.
3	No nodules on non-inoculated control. Plants green.	Soil high in mineral nitrogen. No native rhizobia capable of nodulating that legume.
4	Small nodules on non-inoculated control. Plants deep green.	Soil high in mineral nitrogen. Native rhizobia may be effective or ineffective
5	Non-inoculated control plants have numerous large nodules. Plants deep green color.	Native rhizobia ineffective and effective. Inoculation not necessary.
	Inoculated Plants.	
6	Nitrogen control - nodulated – nodules small. Plants green.	Ineffective rhizobia. Nodules not active because of nitrogen level.
7	Inoculated plants have no nodules. Plants yellow.	Improper inoculum or rhizobia in inoculum dead.
8	Inoculated plants have small nodules and deep green color.	Soil high in mineral nitrogen. Nodules not operating.
9	Inoculated plants have large nodules, red on the inside. Plants deep green. Non-inoculated control has small nodules or no nodules and yellow color.	Native rhizobia ineffective. Inoculant highly effective.
10	Inoculated + nitrogen – plants larger and greener than those receiving only inoculant. Nodules small to medium.	Rhizobia not adequate. Need more effective strains.
11	Inoculated plants receiving phosphorus and potassium – larger, more vigorous than non-fertilized plants from inoculated seed.	Soil low in phosphorus and potassium. Needs fertilizer for maximum nitrogen fixation.

9.2 Methods of Inoculation: Firstly rhizobia are grown in culture in the laboratory. These cultures are then mixed with various inert, finely pulverized solids, such as compost, bagasse, graphite or some suitable carrier. The mix is usually applied to legume seed before planting. This ensures that effective nodules are formed and the plants have a dependable supply of nitrogen. Another method is to apply the inoculant directly to the soil. This alternate is more expensive and is necessary under some circumstances. When the soil is heavily infested with large populations of ineffective non-nitrogen fixing strains of rhizobia, soil inoculants can introduce a larger inoculum of effective rhizobia than can be applied directly to the seed. Seed can also be coated with inoculant. A water in-soluble adhesive such as polyvinyl acetate, polyvinyl alcohol, polyurethane, polyurea varnishes or resins are dissolved in solvents and used to bond the particulate substances to the seed. Non-acid Micronutrients and non-toxic, systemic pesticides can be combined for coating the seed in this manner. Molybdenum and Cobalt can be applied

[1] Legumes & Inoculations, courtesy NARC.

directly to large legume seeds like peas, soybeans or mung beans but not to small seeded varieties such as alfalfa or clover.

9.3 Mineral Nutrition of the Symbiosis: The advantage that a well nodulated leguminous plant has is that its nitrogen supply is not immediately available to weeds. However, it requires all the other essential elements such as phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, zinc, copper, cobalt, molybdenum and chloride. Calcium moderates the toxic effects of aluminium and manganese ions on plant growth, which can also limit nitrogen fixation. Deficiencies in phosphorus, potassium and sulfur result in decreased growth of the legume. This, in turn, reduces total nitrogen fixation. It is important to balance all the nutrients required. Since sulfur is a constituent of many amino acids, a deficiency of this nutrient can result in lower plant protein yield. Combined nitrogen has an adverse effect upon nodulation and nitrogen fixation. However, if prudent use of nitrogen is made for stimulating plant growth and improving photosynthetic capabilities, it can prove to be beneficial especially in large seed legumes. The nitrogen fixing enzyme nitrogenase is composed of molybdenum and iron. Without adequate quantities of these two elements fixation cannot occur. Peas and soybeans need 20 to 22 grams per hectare of molybdenum. Iron is a constituent of red legaemoglobin in the nodule that protects nitrogenase from oxygen inactivation. It is not feasible to apply iron to the seed. However, chelated iron can be applied as a foliar spray when plants show iron deficiency or in soils known to be iron deficient.. This is most likely in alkaline soils. Boron is involved in meristematic activity in both the nodule and the host plant. Without boron, the nodules cannot function. Zinc, manganese, chloride, iron and cobalt are needed for host growth but do not effect nodulation. Copper deficiency results in the development of numerous small nodules.

9.4 Inoculation Costs: At present the inoculant available from the NARC, Islamabad cost just Rs. 24.00 per acre. In soybeans that fix 100 Kgs. of nitrogen per hectare this is equivalent to 217.39 Kgs of urea. At Rs. 360.00 per 50 Kgs this comes to an equivalent of Rs. 1,565.21 or a 30:1 benefit/ cost ratio. With 20 to 60 % increases in yield, as reported for various crops, this benefit/ cost ratio is even more pronounced. Thus it should be quite clear that the potential benefit of inoculation is quite high and the cost is extremely low.

9.5 Inoculation Recommendations: Peas, Mung and Soybeans. Apply graphite based inoculant using 4.4 grams inoculant in 7 mL of water per Kg. seed.

9.6 It is highly recommended that a laboratory for production of graphite based inoculant for Mung Bean (*Vigna mungo*) fixing 63 to342 Kgs. Nitrogen per hectare per year {*Rhizobium* spp. cowpea type, *Bradyrhizobium* sp. (*Vigna*)}. Peas (*Pisum sativum*) fixing 52 to 77 Kgs. Nitrogen per hectare per year (*Rhizobium leguminosarum*) and Soybean (*Glycine max*) fixing 10 to 168 Kgs. Nitrogen per hectare per year (*Rhizobium japonicum*), should be established. Abbottabad District would consequently benefit from increased pure nitrogen fixation, increased yields and high-price varieties being grown. Moreover, the adjoining Districts of Manshera and Haripur would find a ready supply within economically feasible distance.

9.7 Mung – Mash - Soybean Calendar:

9.7.1 May:

a). Turn soil once and cultivate, ensure leveling and apply planking (soybean will require more cultivation and double planking).

b). Arrange Certified seed and Rhizobium inoculant. Niab series of Mung are recommended for increased production. This variety matures in 55 to 70 days as opposed to earlier 100 day varieties. Plant is short in height and thus not easily

damaged by rain. The varieties are also pest resistant. Seed rate is recommended at 8 to 10 Kgs. per acre. Fertilizer requirements are met with One Kg. Nitrogen Fertilizer per acre is recommended to get the seed of to a good start, one bag each of TSP and SOP per acre will suffice for a balanced NPK as N fixation is expected. Mash seed rate is recommended at 6 to 7 Kgs per acre. Mash No. 88 seed yields 25 % more than earlier varieties. Soybean seed is recommended at 30 Kgs. per acre. Seed treatment with Natural rooting and fruiting hormones at 60 mL.

9.7.2 June:

a). Plant after first monsoon rain for Rainfed areas. Mung and Mash planted in last week, soybean planting should be completed by the end of this month. Mung bean seed can be treated with 15 to 20 mL of Natural rooting and fruiting hormones. Mash seed can be similarly treated with 10 to 15 mL. Single row cotton drill seeding is recommended. Seed depth is 3 to 5 cm and inter-row distance at 30 cm.

9.7.3 July:

a). Complete planting Mung and Mash by before the end of the month.

b). Complete planting of irrigated soybean before the end of this month.

c). When Mung plants are 8 to 10 days old they should be thinned to an inter plant distance of 8 to 10 cm.

d). Cultivation is required 15 to 20 days after emergenge.

9.7.4 August:

a). Mung does not require too much irrigation. However, in case rains are delayed Mash will require watering. Mash is subject to bacterial pests thus crop rotation and seed selection will count for protection. Both Mung and Mash will benefit from 250 grams of chelated sulfur applied as foliar spray with 150 L of water per acre.

b). Cultivate Mung, Mash or Soybean on flowering and apply water in case of delayed rains.

c). Weeding is essential for a good yield.

9.7.5 September:

a). Provide plant protection to Mung, Mash or Soybean.

b). Harvesting of quick maturing Niab varieties of Mung can commence by mid month.

9.7.6 October:

a). Harvest of Mung and Mash begins by mid month. When 80 to 90 % of the beans are ripe, harvesting can commence. Harvesting is carried out in the early hours of the morning, when plants are wet with dew, to avoid seed shedding. Dry harvested crop in the sun before threshing. Dry beans thoroughly before storing.

b). Soybean harvest begins by end of October. When leaves turn yellow there is a danger of seed drop, therefore harvesting should be carried out promptly.

9.7.7 November:

a). Soybean harvest continues during this month. Crop can be sold to P.O.D.B., Islamabad.

9.8 Pests: Mung and Mash are subject to the following pest attacks if crop rotation, proper seed selection and good cultural practices are not ensured and incomplete nutrition is provided. Soybean is subject to serials 2, 4, 5, 7, 8 and also to mites (Jooain).

Table 20: Pests and Diseases of Mung & Mash.

Sr	Type	Local Name
1	*Chrotogonus trachytperus*	Toka tidda
2	*Aphid craccivora*	Sust Tela
3	*Callothrips indicus*	Thrips
4	*Empoasca kerri*	Chust Tela
5	*Bemisia tabaci*	Sufaid Makhi
6	*Heliothis armigera*	Taad Ke Sundi
7	*Spodoptera citura*	Lashkari Sundi
8	Yellow Mosaic	Mozaic
9	*Cercospora* sp.	Paton kay Dhabbay
10	*Botrytis cinerea*	Pholon ka Jhulsao

9.9 Protection can be provided by spraying plants with chelated sulfur and Natural oil surfactant mixed with biological anti-oxidizing agents.

10. LENTILS:

10.1 Masoor Calendar:

a). October:
- i. Turn soil once and cultivate. Ensure leveling and apply planking.
- ii. Inculcate compost or well rotted farm yard manure as per availability.
- iii. Complete sowing by 15th October. Recommended seed Masoor 85 at 8 Kgs. per acre. Seed treatment of 15 mL Natural rooting and fruiting hormones and Rhizobium bacteria is recommended. Fertilizer regime is recommended at ½ bag Ammonium Sulfate, 1 bag TSP and ½ bag SOP. Seeding by single row cotton drill provides better results. Inter row distance of 25 cm and inter plant distance of 5 to 7 cms is recommended.

b). November:
- i. If water is available apply irrigation.
- ii. Ensure weeding 2 weeks after emergence, as plants are small with weak stems and subject to suppression by weeds.
- iii. Mulching will provide great benefit to the crop.

c). December:
- i. Cultivate crop in moist condition and remove weeds.

d). January:
- i. Remove weeds and apply plant protection as required.

e). February:
- i. Remove weeds and apply plant protection as required.

f). March:
- i. Remove weeds and apply plant protection as required.

g). April:

i. Harvest crop in the early morning hours when wet with dew to avoid seed shedding. Allow to dry for 2 to 3 days and thresh. A crop of 400 to 600 Kgs. per acre should result.

10.2 Pests and Diseases: Lentils subject to the following pest and diseases if crop rotation, proper seed selection and good cultural practices are not ensured and incomplete nutrition is provided.

Figure 21: Pests and Diseases of Lentils.

Sr	Pest/ Disease Name	Local Name
1	Grass Hopper	Toka
2	Cut Worm	Chor Keera
3	Lentil Pod Borer	Masoor ke Sundi
4	Gram Pod Borer	Channay ke Sundi
5	Rust	Kungi
6	Blight	Jhulsao
7	Stem Rot	Tannay ka stern
8	Root Rot	Jarh ka stern

10.3 Protection can be provided by spraying plants with chelated sulfur and Natural oil surfactant mixed with biological anti-oxidizing agents.

11. RAPE, MUSTARD, CANOLA:

11.1 These three varieties of oil bearing crop can be and are grown in the District. With conservation irrigation it is possible to greatly increase canola production and thus provide edible oil for human consumption and feed for cattle. Massive population increase has resulted in yearly imports of Rs. 30 to 35 Billions. Obviously this is a great burden upon the exchequer as well as a security risk in times of war.

11.2 Canola possesses 40 % high quality edible oil. It is possible to achieve a reasonable crop even from Rainfed lands. One light cultivation followed by planking is recommended upon such soils in order to preserve soil moisture. Obviously addition of compost will greatly improve soil moisture bearing and preserving capacity. Canola is sown from 15th September to 31st October. Method of sowing is recommended through wheat drill as 2 Kgs. canola seed along with 38 Kgs. Triple Super Phosphate (TSP) or 38 Kgs. dry soil/ sand, per acre. A 12 hours seed soaking along with 4 mL Natural Hormones and sowing via drill after drying seed in the shade is highly recommended. Seed is planted in rows that are 1 to 1.5 feet apart and recommended sowing depth is 1 to 1.5 inches. Recommended fertilizer is:

11.3.1 Ammonium Sulfate 1 to 2 bags (50 to 100 Kgs.).

11.3.2 Triple Super Phosphate (TSP) 1 bag (50 Kgs.).

11.3.3 Sulfate of Potash (SOP) 1 bag (50 Kgs.).

11.3.4 Chelated Sulfur 500 gms/ 500 mL.

100 Kgs. of Canola seed will yield 32 Kgs. of High quality edible oil and 68 Kgs. of meal. This meal is an excellent source of feed supplement for cattle and small ruminants. With a yield of at least 100 Kgs. Canola Seed per kanal the returns and benefits are self-evident. Mini micro

enterprise of small oil expellers can prove to be lucrative business. This is all the more true when taken in conjunction with attar, other essential oils and medicinal plants.

11.4 Rape and mustard are important vegetable and fodder crops. They are known for a fast and vigorous crop between the rainy and winter season. The crops are used as soilage or grown as vegetable and oil seed crops. Rape and mustard thrive quite well in cool and moist conditions to be found in temperate regions. These plants cannot thrive in frost, heavy rains, drought conditions or water logging. The plants require pH values ranging from 6 to 8 and do well on clayey loam.

11.4.1 A single run of the cultivator followed by planking and rolling is the best preparation for a firm and fine seed bed to ensure good germination. Provision of seed treatment with natural rooting and fruiting hormones in addition to Sulfur and Molybdenum and other trace elements will greatly enhance the germination, drought resistance and yield of the crops. A good supply of Nitrogen and compost/ farm yard manure is a must. Phosphate and Potash fertilizer as basal application and top dressing with Nitrogen six weeks after sowing will produce very good results. Seed should either be broadcast or drilled to a depth of 1.5 to 2 cm. (6 to 7 Kgs.). In drilled seed the row to row distance is 25 to 30 cm. This is increased to 50 cm in case of dry, rainfed conditions. The crop is sown with the last monsoon rains and harvest can begin by November.

11.4.2 Crop mixtures can be made with shaftal. This crop is initially slow growing and rape can serve to give a good herbage yield. When grown with oats, green forage yield is increased after 8 to 9 weeks.

12 FODDER:

12.1 Small Grain: Bajra (Millet), Jowar (Sorghum) and Barley are the three small grains that are grown in the District. These crops are grown for fodder. As such only one bag (50 Kgs. of Ammonium Sulfate is recommended as source of Nitrogen. The crops are sown between May and July while a second crop of Jowar is sown in August to be harvested in October for winter-feed. Recommended seed rate for Bajra is 6 Kgs per acre with seed treatment of 12 mL Natural rooting and fruiting hormones. Drill seeding at 30 cm inter row distance provides better results. Bajra provides 5 to 20 MT fodder per acre, if grain harvest is taken 320 to 400 Kgs. per acre yields can easily be achieved. A hybrid variety called Bajra Elephant Grass type 13 is available for use. This variety provides multiple cuts, is disease and pest resistant and can be used for soil conservation. This variety is also suited for range land seeding. The variety is planted through plantlets at the rate of 11,000 per acre which can be obtained from 0.25 kanals. In case of availability of water through tubewells, channels, rain guns etc. a variety called Multi Cut Bajra can be grown for dual grain and fodder purposes. Seed rate is 3 to 4 Kgs per acre treated with 10 mL Natural rooting and fruiting hormones. Fertilization by Nitrogen (Ammonium Sulfate) at the rate of 1 bag prior to seeding and 1 bag after each cut is recommended. The crop can be planted in April and will provide fodder throughout the summer. First cut will be obtained after 1 ½ months at around 1 m height. Subsequent cuts can be obtained every 5 to 6 weeks till mid July. Thus three cuts yielding 9, 11 and 12.5 tons each and totaling 32.5 MT can be obtained. Last fertilization of 1 bag Ammonium Sulfate, followed by irrigation, is provided after cultivation between rows. .Yield of 350 to 400 Kgs. per acre of grain is obtained at the last cut. Jowar is grown on level and lower elevations in the South of the District. Seed crop requires a balanced NPK fertilizer, one bag each of Ammonium Sulfate, TSP and SOP provide the required

nutrients. Fodder crop requires a seed rate of 32 to 35 Kgs. per acre with seed treatment of 65 to 70 mL of Natural rooting and fruiting hormones. Seed crop requires 8 Kgs. seed per acre and seed treatment of 15 ml. Seeding by drill with inter row distance of 30 cm yields the best results. This distance is doubled in case of seed crop. In case of less rains crop less than 1-m height should be fed to animals with care as a poisonous substance called Hydro Synic Acid is produced. Thus the crop should be used as fodder only after rains. Plant protection to seed crop can be provided by the use of chelated Sulfur mixed with Natural oil surfactant stabilized with herbal anti oxidizing agents. Crop varieties called Jowar No. 263 and Hegari are recommended for sweetness and better yields. Early first crop is harvested in August while seed crop should be provided with irrigation, if possible, in case of late rains. Seed and late first crop is harvested in September.

12.2 Maize as a Fodder Crop: Maize is the most useful crop for making silage. It is non toxic at all stages of growth as there is no prussic or oxalic acid or ergot disease poisoning. The crop is well suited to the alluvial or red soils. Land preparation to a depth of 10 to 15 cm is sufficient. One mold-board plowing and two passes of a disc plow is all that is required. Fine seed beds are not required, it is more important to have a weed clear field. In barani conditions one deep plowing every two or three years will ensure moisture preservation in the root zone. Maize may be grown from end February to mid September. Fodder maize when grown mixed with legumes will give excellent results. Soybean or other suitable legumes are manifestly advantageous. Fodder maize can be seed up to 60 to 90 Kgs. per hectare to ensure thin stemmed, leafy crop. Normally 40 to 50 kgs per hectare are used. In mixtures 25 kgs. of maize and 20 kgs. of soybean can be sown in two lines alternately in an east – west direction. In summer the crop can be inter mixed with Bajra or Charri as these crops are heat and drought resistant. One bag each of Nitrogen, Phosphorus and Potash will have a very good effect upon the yield. Zinc will also help the yield at 1 L per acre along with top dressing of 1 bag Nitrogen at 5 weeks growth. Sulfur will act as an pesticide and nutrient, this can be foliar applied in the third week of growth at a rate of 500 mL per acre along with 200 L of water. Seed treatment with 100 ml Natural rooting and fruiting hormones along with 200 mL of Zinc will prove to be most beneficial. Yields vary from 20 to 50 tons per hectare depending upon the season. Summer yields are lower than wet season crops.

12.3 Vetches: Vetches are important as a forage crop in clod climates. Sown at a rate of 40 to 50 kgs. per hectare vetches will provide good yields in moist conditions and average yields under dry conditions. A good supply of Phosphorus and adequate supply of Nitrogen produces best results. There are many varieties of vetches and it is recommended to carry out field trials for this crop.

12.4 Lucerne Alfalfa: This plant can be grown for pasturage, silage, hay, dehydrated meal and medicinal purposes. It is a persistent, productive, heat resistant and drought resistant crop. Lucerne can be used as a fodder rotation crop as well as for soil conservation. Lucerne is a leguminous plant and fixes Nitrogen in the soil. The plant is adapted to below sea level to 2440 m above sea level. A good yield can be achieved with good tilth as well as good compost or farm yard manure content. One mold-board followed by a single disc harrow will be good preparation of the soil. Seed is hard and requires 6 to 8 hours soaking followed by scarifying or rubbing. If grown for the first time in a field the seed should be inoculated with Rhizobium meliloti culture. Fertilization with P, K, Ca and S will provide excellent yields.

12.5 Building Fertility Levels with Forage Crops: After several years of intense cereal cropping the farmer will find a reduction in yield. This is due to physical as well as chemical

deterioration of the soil. Fodder crops prove to beneficial as a rotational crop to replenish the soil. Cereals and other arable crops have a tendency fo exhausting the soil and destroying the crumb structure.

12.6 Competitive Growth between Grasses and legumes:[1] Fodder crop production can be enhanced with mixtures of grasses and legumes. Ultra simple mixtures consist of a single variety of each species. Complex mixtures consist of more tan one or two grasses mixed with more than one legume. In cases of pasture land, in order to make most use of land and sun (permaculture) bushes and fodder trees are grown as silvi-pasture systems. Herbs with different growth rhythms are grown oin mixtures to gather maximum yields all through the year of the most part. This requires a complete knowledge of growth rhythms in the area of choice. Inter species and Intra species competition can only be avoided with this rather complete knowledge based upon tests and trials. The symbiotic fixing of Nitrogen by the legumes and the resultant better balanced diet of grass and legumes mixtures provides benefit to the soil as well as grazing animals. Some generalizations between pure and mixed cultures was provided by Donald (1963).

a). Yield of a mixture will usually be greater than that of the lower yielding culture.
b). Yield of a mixture will usually be less than that of the higher yielding culture.
c). Yield of the mixture may be greater or less than the mean yield of the two pure cultures.
d). There is no substantial evidence that two pasture species can exploit the environment better than one.

13 AGRICULTURAL WASTES:

13.1 At present, in Pakistan, there is an over abundant use of Chemical fertilizers. Especially Urea and DAP. Increased run off and leaching of these two fertilizers has resulted in damage to the environment. This is due to the fact that not all the fertilizer is taken up by the plant. This situation is further aggravated by the fact that we are encouraged to apply the fertilizer in broadcast and that too at a time when it is least needed by the plant. The fertilizers are not stabilized and Volatilization results. Thus Nitrate Nitrogen and Phosphorus runoff/ leaching takes place. This results in the following:

13.1.1 Eutrophication: Large quantities of Nitrogen and Phosphorus enter our water bodies every year due to run off. Phosphorus is a scarce element in nature. Thus many Eco-Systems have adjusted to low levels of Phosphorus. When large quantities are made available, due to overuse by human beings, limits are lifted. This results in ‘blooms’ within water bodies at concentrations even as low as 50 ppm. Nitrogen then becomes the limiting factor and phyto-plankton is the first to suffer. This is the food for fish. Blue green algae takes over from plankton because it escapes the Nitrogen limits. This deprives biota of their food of preference and results in accelerated aging of lakes by nutrient enrichment or eutrophication.

13.1.2 Leaching: Nitrates are negatively charged and are thus repelled and subject to movement with soil water or leaching into groundwater reservoirs. Metabolic disorders in animals and children results. This includes the human condition of methemoglobinemia. Here the binding action of Nitrates prevents the hemoglobin from taking up oxygen. This is

[1] Forage Crop Production, Principles and Practices. B N Chatterjee and P K Das, 1989.

called the blue baby syndrome. Excessive Nitrates also effect the normal development of brain cells in children. FDA tolerance levels are 40 mg per Liter.

13.2 These are the more benign forms of Pollution caused by Agricultural Chemicals. Pollution is defined as the introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to living resources and Ecological Systems, damage to structures or amenity, or interference with legitimate uses of the environment.

Table 22: Waste Pathways.

Organic wastes	Air	Fresh Water	Oceans	Land	Clinical Effects on Humans
Fertilizer Residues	X	O	O	O	Yes, especially N2

X = Environments into which wastes are discharged.
O = Environments into which wastes get transferred.

13.2 Pesticides: It is estimated that pests and pathogens (all harmful organisms that damage crops) destroy 10 – 40 % of the world's gross agricultural production.[1] However, the indiscriminate use of pesticides (products that control insects, mites, snails, nematodes and rodents), fungicides and bactericides (products that control diseases) and herbicides (products that control weeds) is not the ideal answer to controlling/ limiting this loss. These products can and often do prove to be harmful to life as well as to natural resources. Secondly, they are inefficient in controlling the problem for which they are used. They often end up by eliminating the natural enemies of these organisms and thus cause pest resurgence. Pests and weeds also have a tendency of becoming resistant to these products. Strict regulation in the developed world has led to better products. However, we in Pakistan and especially in remote Districts face the problem of indiscriminate dumping of harmful products. Modern Agriculture has evolved systems of agroecological predation, competition and parasitism to control pests. Lack of legislation, misunderstanding of hazards and poor labelling lead to a greater incidence of pesticide poisoning in Third World Countries. A market survey of Abbottabad District has revealed the presence of Internationally banned pesticides. Cheap imitations of pesticides are an even more dangerous factor. This is due to lack of quality control in production and also ineffectiveness for the purpose they are intended. Thus farmers face the double hazard of health risk and wasted input.

13.3 Harmful Effects of Unregulated Agri-Chemicals: There are two major hazards associated with unregulated and unregistered Agri-Chemicals:

a). Direct poisoning resulting in cancers and general toxicity.
b). Endocrine disruption/ Reproductive impairment.

EDCs are endocrine disrupting chemicals. The endocrine system is present in nearly all animals. This includes mammals, non-mammalian vertebrates (fish/ reptiles), birds and invertebrates (snails, lobsters, insects etc.). The system consists of glands (thymus, parathyroid, thyroid, pancreas, ovaries and testis) and hormones produced by them. Hormone is a Greek word, meaning to urge on. Bio-chemicals travel through the bloodstream and cause responses by acting through special cells called receptors. These receptors turn on bio-activity in response to these bio-chemical signals. Some chemicals mimic hormones and trick these receptors into over reacting, other chemicals may block hormones. Some chemicals directly stimulate or inhibit production of hormones causing over/ under production. Some chemicals, through this process,

[1] Regenerating Agriculture, Jules N Pretty, Earthscan Publications Ltd. 1995.

cause abnormalities of the reproductive system leading to feminization of males and masculinization of females. Other chemicals result in enlarged thyroid glands, birth defects, behavioral changes, depressed immune systems and increased vulnerability to diseases. A 1991 WHO study has revealed 55 % increase in testicular cancer, decline in sperm count, increase in female over male births as a result of dioxins (1 grain of dioxin can kill). Incidence of breast cancer and early onset of puberty due to EDCs. A 1998 UN Report reveals that 5,00,000 Pakistanis suffer annually from poisoning by Agri-Chemicals per annum. Around 10,000 eventually perish. The long residual and highly lethal chemical DDT was banned in Pakistan in 1993. However, 5,000 Kgs. of this chemical were smuggled into Pakistan from India in 1997 alone.

14 AGRICULTURE RESEARCH:

14.1 Abbottabad District is the Gateway to the Mountainous North. It is ideally suited to Education and Research Institutions. There is no Research Institution for Alpine & Sub-Alpine Agriculture in the entire region. It is imperative that such an Institution be established. Not only for basic applied and adaptive research but also to impart training and skills regarding the peculiar type of agriculture that is inherent in the altitude, longitude, latitude and climate of the region. Such a measure will go a long way in bettering the lot of the inhabitants of the region. It will equip them with the basic knowledge and skills to take up the challenge of providing for themselves in the 21st Century. The Humboldt University in Berlin, Germany, has come up with a unique method of ensuring that Research is in tune with market demands. Their new campus for the modern and newly emerging disciplines like Information Technology, Micro-Biology etc. is being established with close cooperation of the Private Sector. The new campus will house as many Private Business individuals as students. Thus the Micro-Biology Department will work in close conjunction with Companies dealing in Micro-Biological products. Students will be able to take up Research Themes that will find a ready market. Upon graduation they will be able to find employment as well. This is all the more pertinent due to the fact that young minds are able to take up challenges and are more ready to accept new concepts and ideas. The emerging Technological Revolution will afford plenty of opportunity to face challenges and new concepts. We must consider something along similar lines. This too specifically in the fields of Agriculture and Agri-Business as well as Hi-Tech Electronics and Information Technology.

14.2 A huge and sprawling estate in the shape of the Bara Galli Summer Campus for the Peshawar University is presently under utilized. At hardly an hours drive from Abbottabad City this estate is linked with an excellent all weather road to both Abbottabad and Murree. At present the Peshawar University uses this facility for just three months in a year. Around 500 students and Faculty can easily be accommodated in this facility. The site was developed from 1900 to 1908 as a Center for the Gurkha Battalion. Without displacing the existing setup it is quite possible to utilize this excellent facility as a Research cum Teaching Center for Hill-Side Farming. Presently the inhabitants of the District are using wheat seed that is adapted to the hot and irrigated plains. The maize seed that was once famous for its quality has deteriorated to a scrawny plant that hardly justifies its existence even as a fodder plant what to talk of grain for human consumption. Similarly, cold weather horticulture crops like vegetables and fruit can be thoroughly researched and introduced through this facility. The compiler of this report had occasion to sit in on a meeting between the Federal Secretary MINFAl, the Chairman of the Agriculture Faculty of the Humboldt University and a representative from the Faisalabad

Agriculture University. The issue of a post graduate degree in International Agriculture and possible student exchange between Humboldt university, Berlin, Germany and Faisalabad Agriculture University was under discussion. The compiler of this report pointed out that the Germans were experts in Alpine and Sub-Alpine Agriculture and the District of Abbottabad could benefit greatly from their expertise. Secondly, the summer heat of the Punjab could prove to be a serious drawback in extended association with Faisalabad. Summer exchange as well as a permanent association with Abbottabad District could prove to be mutually beneficial to both Germany as well as Pakistan in general and the inhabitants of the Mountainous belt of Pakistan in particular. Both the federal Secretary MINFAL and the Chairman of the Agriculture Faculty of Humboldt University warmly welcomed the idea. Prof. Dr. Shwartz of the Humboldt University pointed out that they would not be able to include a long lead-time of construction and establishment of such a facility. In case the Peshawar University, in the greater Public Interest of the local Inhabitants of the region, would consider an association with the Humboldt University in this regard it would be a great service to the inhabitants of the entire mountainous belt of Pakistan.

14.3 The Agricultural System:

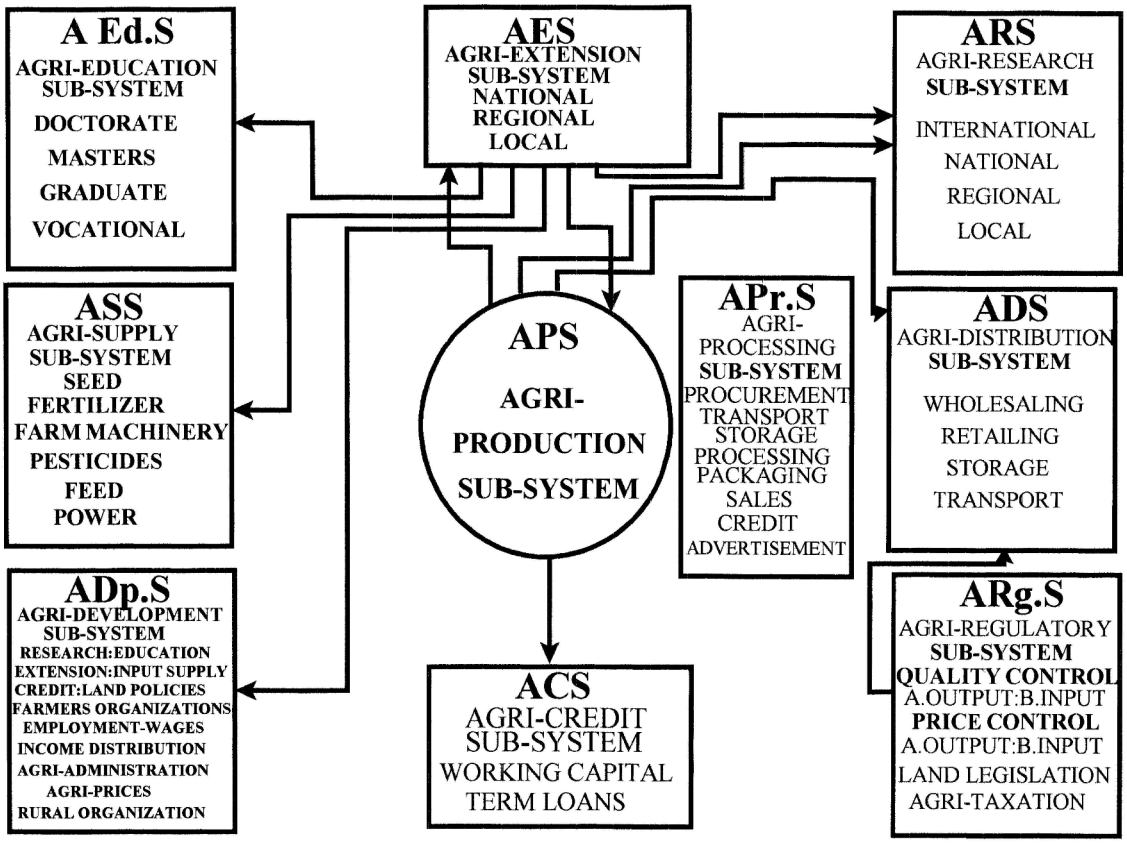

Figure 9: The Agricultural System.

14.4 Management of Agricultural Research: Agricultural research is a continuos and on-going process. Its management process takes place within the two dimensions of fields, commodities and people. It is important to understand the setting within which this sub-system operates. This is what lends relevance to Agri-research. People include at one end, the policy makers,

administrators and financiers. At the other end are the producers, processors and consumers. Between these two are the core people like the scientists, other research workers and extension workers who carry the research to the end users.

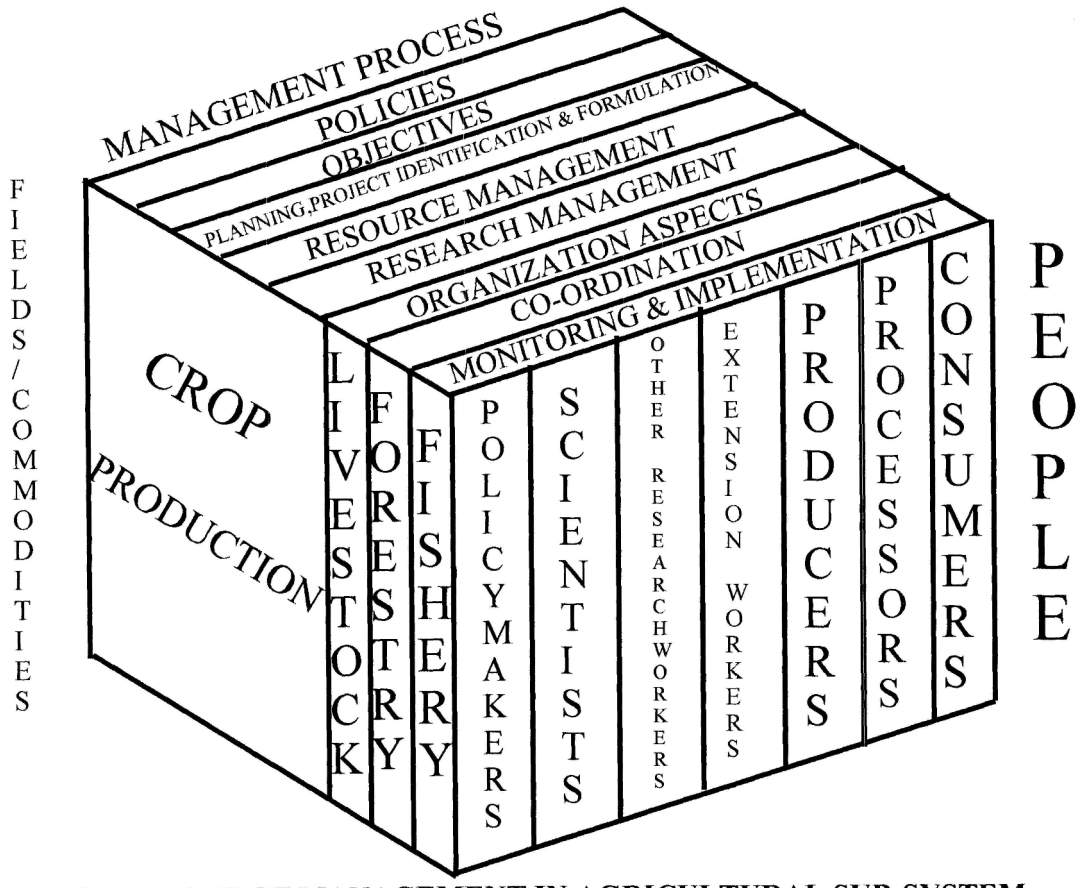

Figure 10: 3-D Of Management in Agri-Research.

14.5 Management Process: The management process in Agri-Research deals with the following:

14.5.1 Formulation of Research Policies.
14.5.2 Objectives.
14.5.3 Planning, Project Identification and Preparation.
14.5.4 Assessment of resource requirements, mobilization and allocation.
14.5.5 Management of resources, including:
- a) Research scientists.
- b) Other research personnel.
- c) Physical resources.
- d) Financial resources.

14.5.6 Organizational aspects of intra-project, inter-project and inter-institutional nature.
14.5.7 Coordination between research and other activities of the institution.

14.5.8 Monitoring and implementation.
14.5.9 Transfer of research results.
14.5.10 Evaluating impact of research results.
14.5.11 Feed-back.

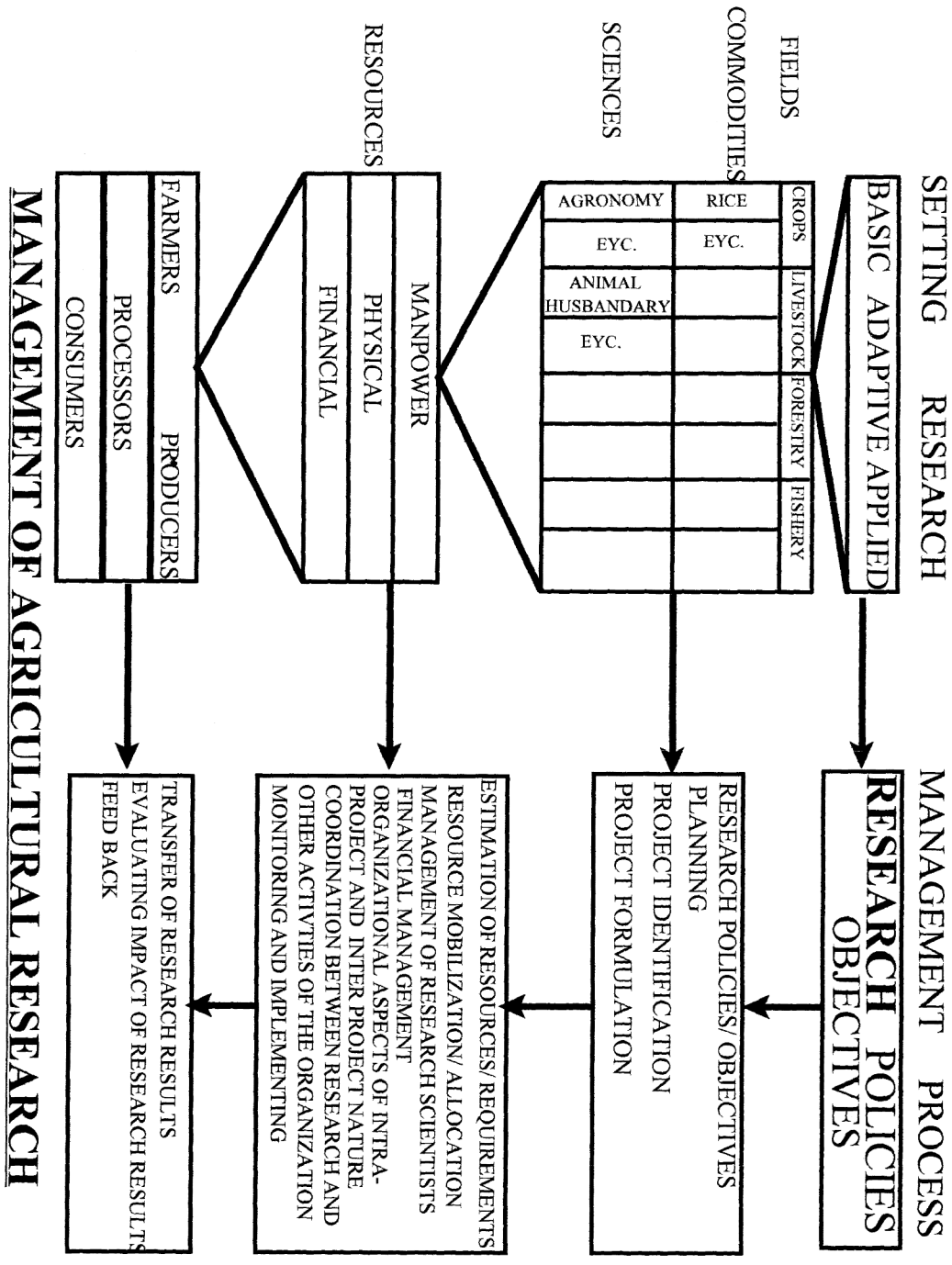

Figure 11: Relationship between Management Process and Setting.

15. LEISA: A development in modern agriculture, termed as Low-External-Input and Sustainable Agriculture. This is sustainable agriculture based upon ecological principles.

15.1 LEISA is an approach to sustainable agriculture that builds upon:[1]

15.1.1 Agroecology: A scientific knowledge base from which ecological concepts and principals can be applied to the design and management of sustainable agroecosystems.

15.1.2 Indigenous knowledge: Knowledge farmers have of their locality, generated from their own and their ancestors experiences. It includes knowledge originating from outside the region that has been internalized. Indigenous knowledge is holistic and encompasses all aspects of rural life.

15.1.3 Scientific Knowledge: Knowledge base developed by scientists.

15.1.4 Participatory learning, planning and action: Participation of development supporters in local development processes to strengthen farmers own capacities to adapt to changing needs and conditions, towards sustainability.

15.1.5 Economic viability, ecological soundness, social justice and cultural integrity: Sustainable development is important but should not be pursued at the expense of the cultural and social values of those segments of the population who have little influence over economic and political decision making.

15.2 The International Low External Input Agriculture (ILEIA) Organization has come up with a Collaborative Research Program which is designed to accommodate three interactive lines of activity:

15.3 Participatory Technology Development (PTD): This is essentially a purposeful and creative interaction between rural people and outside facilitators. This process of technology development not only attempts to find solutions to current problems it also tries to develop sustainable agricultural practices that conserve and enhance natural resources for future generations. Most importantly PTD aims to strengthen the capacity of farmers and rural communities and enable them to analyze ongoing processes and develop relevant, feasible and useful innovations. There are six main steps in PTD:

15.3.1 Getting Started: Building relationships for cooperation; preliminary situation analysis; awareness mobilization.

15.3.2 Looking for Things to Try: Identifying priorities; identifying best-bet options from indigenous knowledge and scientific sources; screening sources.

15.3.3 Designing Experiments: Reviewing existing experimental practices; planning and designing experiments; designing, monitoring and evaluating protocols.

15.3.4 Trying Things Out: Implementing experiments, monitoring and evaluation.

15.3.5 Sharing the Results: Communicating basic ideas, principles, results and the PTD process; training in skills, proven technologies, use of experimental methods and farmer to farmer extension.

15.3.6 Keeping up the Process: Creating favorable conditions for continuing experimentation and agricultural development.

15.4 Stakeholder Concentrated Action: SCA aims to strengthen local participatory development processes by creating stakeholder working groups or platforms. In agriculture development such stakeholder groups involve farmers and other land users, development workers, researchers, policy makers, banks and agribusiness. Stakeholders have a clear interest in working together to achieve a common goal while at the same time ensuring that each others interests are taken into account. Concentrated actions provide SCA with a focus. These actions imply:

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[1] ILEIA Newsletter for LEISA, Finding Common Ground. September 1999, Vol. 15 No, 1/ 2.

15.4.1 Analysis.
15.4.2 Developing an Action Plan.
15.4.3 Conflict Resolution.
15.4.4 Monitoring and Evaluation.
15.4.5 Information Exchange.
15.4.6 Lobbying.
15.5 Assessment Research:
15.5.1 Scientific Monitoring and Validation of Farmer Practices.
15.5.2 Experiments and Farm-Household Systems. (FARMS) This is a computerized Management Data System based on the FoxPro Database Management Software Program. It allows quick data entry and cross-checks. It has the potential to rapidly analyze the various aspects of farm management including the results of:
a) Financial Performance.
b) Agriculture Production.
c) Labor Requirements.
d) Nutrient, Energy and Groundwater Balances.
e) Sustainability Indicators at Plot, Crop, Crop Group, Enterprise and Farm Level.
15.5.3 Exploratory Studies on History Trends.
15.5.4 Sustainability of Agriculture in the Region.

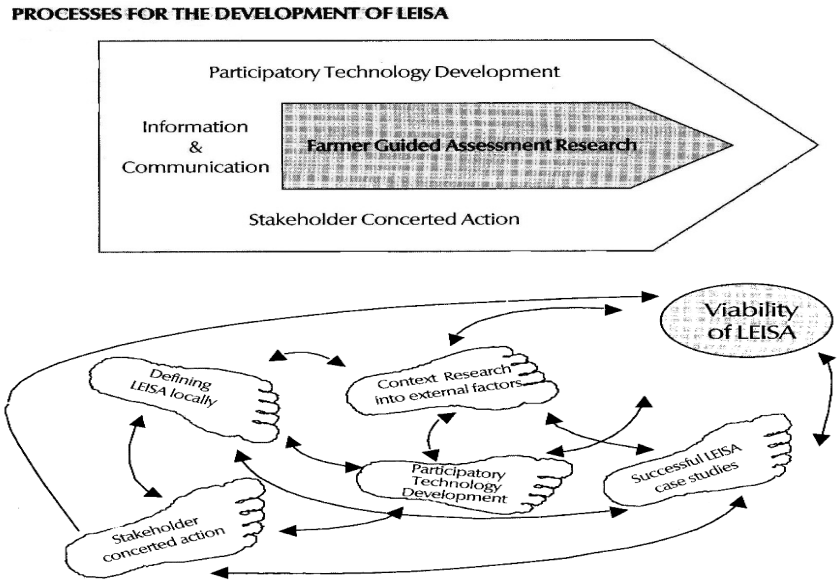


Figure 12 : Big & Small Boats for LEISA Development:
Figure 13 : Strategic Footsteps: Iterative Steps in the Development – Research Process.

Table 21: Criteria for LEISA:

Sr	Ecological Criteria	Economic Criteria	Social Criteria
1	Balanced use of Nutrients and Organic matter.	Sustained Farmer Livelihood Systems.	Widespread and Equitable Adoption Potential, especially amongst Small Farmers.

2	Efficient use of Water Resources.	Competitiveness.	Reduced Dependency upon External Institutions.
3	Diversity of Genetic Resources.	Efficient Use of Production Factors.	Enhanced Food Security at the Family and National Level.
4	Efficient use of Energy Sources.	Low Relative Value of External Inputs.	Respect and Build on Indigenous Knowledge, Beliefs and Value Systems.
5	Minimal Negative Environmental Effects.		Contribute to Employment Generation.
6	Minimal Use of External Inputs.		

16. **CONCLUSION:** The District of Abbottabad is as yet not facing severe environmental degradation. However, if present population pressures and subsistence trends continue, there will come a time when the threat of ecological disaster will definitely emerge as reality. The time to take action is NOW! The Khidmat (Service Oriented) Management Approach has been designed with just such problems in mind:

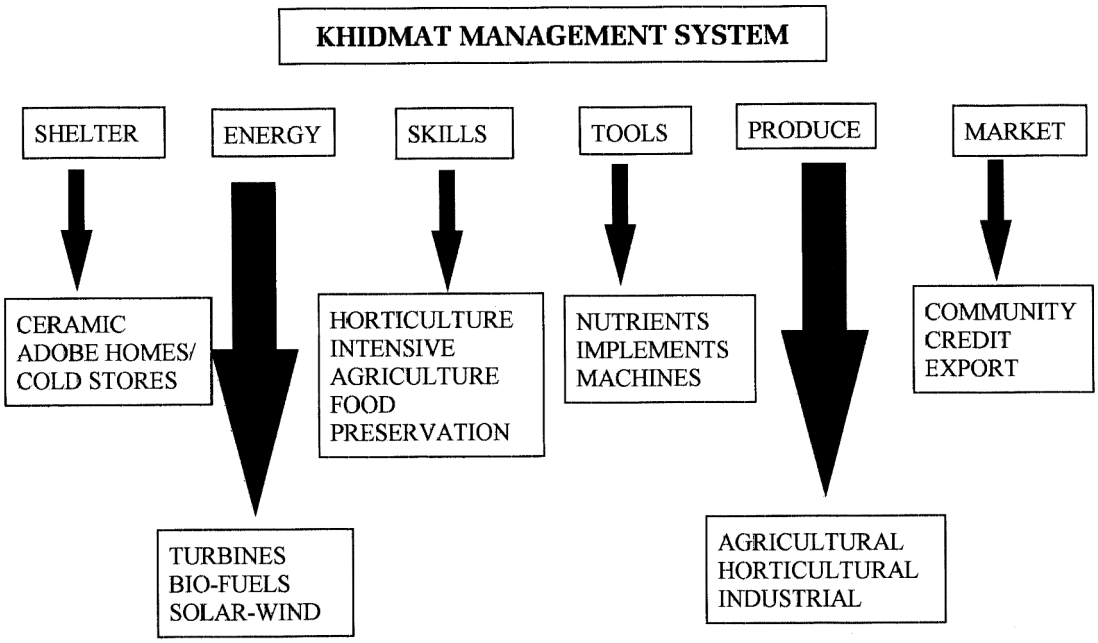


Figure 14: The Khidmat Management System.

CHAPTER 3: HORTICULTURE IN ABBOTTABAD DISTRICT:

1 CURRENT STATE:

1.1 Table 1: Area & Production of Fruit:

ITEM	Area/Hectares	Production/ Tons	Yield/ Hectare
Apricot	5	45	9
Apple	559	4570	8.2
Figs	6	37	6.2
Pears	3	30	10
Peaches	105	92	1
Plums	43	358	7.4
Walnuts	13	108	8.3
Persimmon	6	52	8.7
Others	26	224	8.6
TOTAL	671		

Production per Capita:

Overall: 6.22

1.1.1 Fruit Varieties:

a. Apples: Requirements for apples consist of well drained, deep, rich, moist and calcareous soils. Apple trees are planted in February to April and flourish at altitudes of 1372 – 2286 M. Diseases and pests consist of Coddling Moth; San Jose Scale and Root Rot. Yields are obtained from Aug to Oct and are about 75 to 110 Kg per tree. March flowering varieties are struck by storms and hail stones. Thus early and late flowering varieties need to be introduce. These are mostly grown in Birot; SijiKot and Banda Pir Khan/ Qalanderabad. Various varieties are as follows:

Table 2: Localities/ Varieties of Apples in Abbottabad District.

Sr	Birot	SijiKot	Abbottabad and Surroundings.	Miscellaneous
	Red delicious.	Kashmiri (local maximum).	King Amri.	Stark Crimson.
	Meshedi.	Golden Delicious.	Kala Kolu.	Red Chief.
	Golden Delicious (maximum).	Red Delicious.	Golden Delicious.	Akane.
			Red Delicious.	Elite.

b. Plum Varieties: Plums require alkali free, calcareous soils that are of clay, loam. Plums are planted in February to March and flourish at altitudes of 455 to 1830 M. They are susceptible to Fruit Fly attacks and Gumosis. Yields of 40 to 60 Kg are obtained in May through June.

i. Fazl-e-Minani.
ii. Formosa.

c. Walnut Varieties: Walnuts require rich, deep, well-drained alluvial soils that are loamy. They are planted in February and March and flourish at altitudes of 1200 to 2100 M. stem Borers can cause great damage. Yields are obtained in Aug to Oct and consist of 40 to 80 Kg per tree.

i. Kaghzi.

ii. Katha.

d. Peach Varieties: Peaches flourish on moderately fertile loam to sandy loam. They are planted in February and March. Peaches are susceptible to fruit Fly and Leaf Curl Virus. They are harvested in May through July and carry 30 to 40 Kg per tree.

i. Early Grand.
ii. 6 – A.
iii. Florida King.
iv. Loring.

e. Loquat Varieties: Loquat's thrive on light loamy soils up to altitudes of 1830 M. They are attacked by Fruit Flies and suffer from Bark Crack. Yields are obtained in March and April. Yields of 30 to 40 Kgs. can be obtained.

i. Golden.
ii. Yellow.

f. Apricot Varieties: Deep, well drained, sandy loams are the preferred soils for apricots. They flourish at altitudes of 762 to 1220 M. Gumosis and Fruit shedding effects these trees. This is due to poor nutrition. Fruit Borers also attack these trees. Apricots are harvested in May through July and consist of about 35 Kgs. per tree.

i. Travit.

g. Persimmon: This exotic fruit variety is grafted on to the local 'Amlok', which bears small, black fruit. It thrives on well drained, rich loamy soils. Trees are planted in February and march. These trees flourish up to 1047 M and are attacked by Fruit Flies. September and October harvests are obtained and consist of 300 to 500 fruit.

i. Seedless Japan.

1.2 Table 3: Major Vegetables.

ITEM	Area in Hectares			Production in Tons			Yield/ Hectare	
	Irri	UnIrri	Total	Irri	UnIrri	Total	Irri	UnIrri
Soybean	20	5	25	26	5	31	1300	1240
Chilies	2.4		2.4	2.4		2.4	1000	
Potatoes Summer	64	18	82	545	140	685	8515	7778
Potatoes Spring	171	466	637	1948	5272	7220	11392	11313
Misc.	50		50	376		376	7520	

Production per Capita: Overall: 3.22

1.3 Table 4: Minor Vegetables:

ITEM	Hectares	Production in Tons	Hectare/ Kgs
Turnip	36	783	21750
Carrot	20	441	22050
Spinach	17	364	21412
Tomato	30	315	10500
Cauliflower	7	116	16571
Cabbage	6	31	5167
Peas	11	86	7818
Radish	24	265	11042
Others	6	79	13167
TOTAL	157	2480	15796

1.4 Table 5: Vegetables Planting Information:

Vegetable	Planting time	Harvest	Row to Row	Plant to Plant
Turnip	Aug/Nov	Oct/Mar	20”	3”
Peas	Sept/Oct	Nov/Dec	40”	2.5”
Potatoes	Mar/Jul/Aug	Jun/Oct/Nov	24”	9”
Cabbage	Sept/Nov	Dec/Apr	30”	4”
Cauliflower	Jul/Nov	Sep/Mar	30”	18”
Radish	Jul/Jan	Aug/Mar	28”	3”

1.5 Table 6: Plant Protection by F & V Board (acres):

Year	Apricot	Apple	Peach	Persimmon	Walnut	Other	Vegetables	Total
1992 – 93	2	50	Nil	Nil	Nil	3	Nil	55
1994 - 95	1	32	4	1	9	Nil	4	51
2 Years	3	82	4	1	9	3	4	106

1.6 Table 7: Distribution of Spray Equipment:

Year	Backpack	Portable Power Pack	Total
1994 – 95	41	Nil	41
1995 – 96	40	Nil	40

1.7 Production of Fruit Saplings:
1997 – 1999: Nil.

1.8 Distribution of Fruit Saplings:
1992 – 1999: Nil.

1.9 Table 8: Ownership of Orchards:

Orchard Category	Size of Orchard	Percentage
Small Farmers	2 – 8 Kanals	95 %
Medium Farmers	8 Kanals and above	5 %

1.10 Location:

Apple Orchards are concentrated in Birot, SijiKot and surrounding area of Abbottabad City. Apricot, Walnut and other fruit trees are found in various parts of the District in scattered form.

1.11 Table 9: Ownership of Land under Vegetables:

Category	Size	Percentage
Small	5 – 10 Kanals	90 %
Medium	Above 10 Kanals	5 %

1.12 Tenancy/ Labor Employed:

Orchards and vegetable farms are usually operated through contractors. These individuals arrange for labor.

1.13 Marketing:

1.13.1 Fruit:

The majority of Fruit Orchards are of small size with a few large Orchards. Small growers usually sell their products in the local Fruit Mundies or consume the fruit themselves. Auctions are held for the produce of large Orchards. Thereafter fruit is packed in wooden crates for

onward shipment to either local Mundies or the larger Mundies in Haripur, Taxilla, Rawalpindi and other Mundies in the Punjab and N.W.F.P.

1.13.2 Vegetables:

The growers themselves market vegetables as mainly small farmers produce them. Small private marketing associations and individual entrepreneurs also market these vegetables. The produce of the Rash Plain and Havellian is usually sold in Vegetable Mundies of Haripur, Rawalpindi and Lahore. Vegetables are marketed in Gunny Bags; Cotton Net and Wooded Crates. Off-season vegetables are usually sold in Islamabad/ Rawalpindi Mundies through Collective Marketing Associations especially in the Galiyat Area. Individual growers bring their produce to the roadside. From here the CMAs collect the produce and transport it to the preferred Mundies.

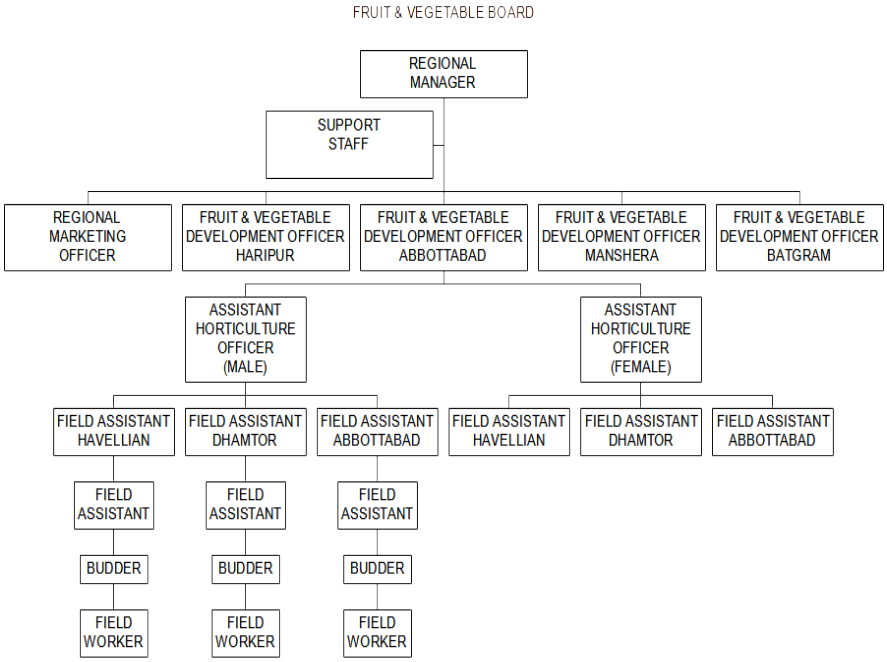
1.14 Gender Role in Horticulture:

Agriculture in Abbottabad District is usually restricted to the production of Cereal Crops. Men carry this out. What little horticulture is pursued is also restricted to men except in remote areas of the Galiyat. This is due to absence of male members who are mostly working abroad or in large Urban Centers of the Country. However, there has been some trend of imparting training and encouraging female participation in horticulture. This has been done through the Fruit & Vegetable Board assisted by Sarhad Rural Support Corporation (S.R.S.C.); Sungi Development Foundation (S.D.F.); Program for Horticulture Promotion (P.H.P.) through their respective Community Based Organizations (CBOs).

2 **FOSTERING HORTICULTURE:** The infrastructure available for fostering Horticulture in the District is as follows:

2.11 Fruit & Vegetable Board:

This Provincial Government Institution has a Nursery and Offices in a central location consisting of 40 Kanals (5 acres) on the main Silk Route in Mundian. This is a small shopping center situated close to Abbottabad City and is readily accessible by Public Transport. The personnel are as follows:



Organization Chart 1: F&VB.

The Board's Women Program is in a position to offer their services to women in Fruit and Vegetable Preservation; Drying; Processing and Kitchen Gardening. There exist a number of constraints in the Women's Program. These are:

a). No budget for activities.
b). No transport for field activities.
c). Lack of leadership.

2.12 Potato Research Center (P.R.C.).

This Center is situated in Mirpur, Abbottabad. It houses a German designed GlassHouse of the late 1980's. The Glasshouse has evaporative coolers along one wall, an Oil Fired Heater, insect proof screens, thermal curtains/ screens and an Air Lock Entrance. Most of these items are damaged and lack repair. Thus they are considered as non-functional.[1] It is concentrating upon the following activities:

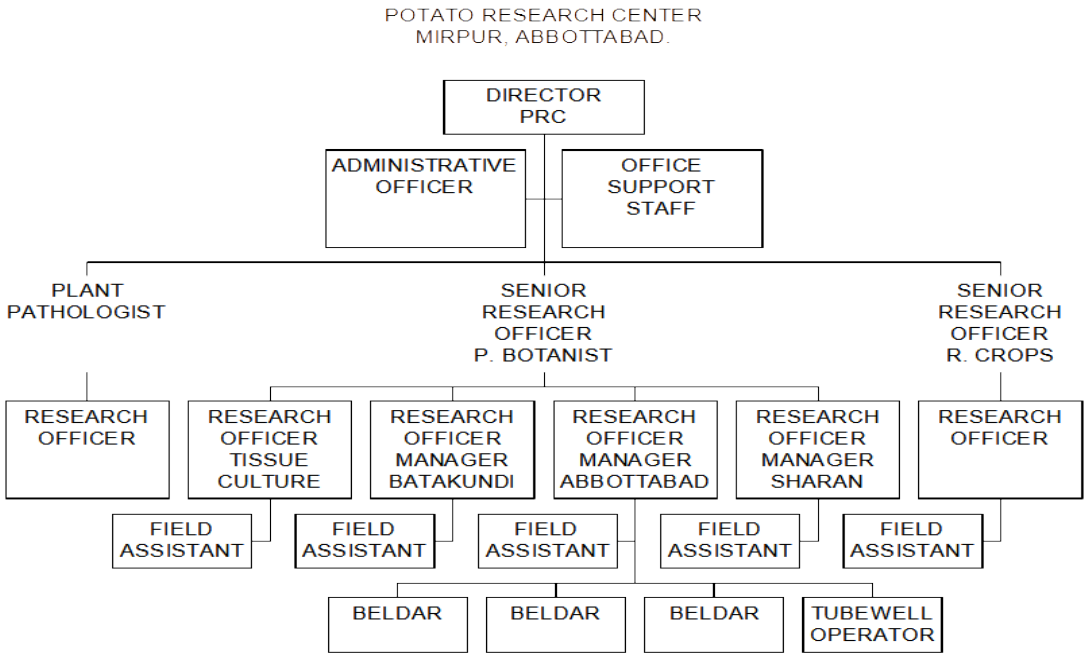
a). Pre-basic Seed Potato Production.
b). Basic Seed Production at Batakundi (Manshera District).
c). Distribution of Seed Potatoes to Farmers.

This Project's facilities are only partially utilized, it also faces some constraints. This results in the meeting of only 1.7- % of Pakistan's Seed Potato requirement. These are:

a). No screening for disease control.
b). No permanent Tissue Culture Specialist.
c). No Alternate Energy Supply in case of power outage.
d). No proper Marketing System.
e). No direct interaction with farmers.
f). Transport in poor condition.
g) Limited Operational Budget.

The PRC is organized as under:

Organization Chart 2: PRC.



2.3 Barani Areas Development Project (B.A.D.P.).

[1] Floriculture Research & Development in the NWFP, Pakistan. OPCV, NESPAK, 1994.

Phase 1of this Project has been completed and is now poised for Phase 2. In the interregnum the Project has been wound up and is waiting proposed funding. Their Offices were also located in Mundian. Their activities were as follows:

a). Fruit Tree Nursery production.
b). Planting of fruit trees.
c). Vegetable Demonstration Plots.
d). Fruit and Vegetable preservation.
e). Farmers Training.

2.4 Sungi Development Foundation (S.D.F.).

Their Zonal and NRM offices are located in Abbottabad City. This is a Private NGO. Their Zonal Office has a Zonal and one Male and Female Coordinator. Their activities related to Horticulture are as follows:

a). Distribution of Fruit Plants.
b). Vegetable Demonstration Plots.
c). Orchard Management Training.
d). Training of Farmers.
e). Kitchen Gardening Training.

2.5 Sarhad rural Support Corporation (S.R.S.C.).

This Organization is a Government sponsored NGO. It is working for Grass Roots Institutional Development. Their Regional Office is situated in Kaghan Colony, near Abbottabad City. Their NRM Coordinator is responsible for horticultural activities.

2.6 Natural Resources Conservation Project (N.R.C.P.).

This is a Government of the N.W.F.P. and I.U.C.N. joint Project. The European Community funds it. Its target area is the Galiyat of Abbottabad District. An Assistant Director Agriculture is responsible for horticultural activities.. The I.U.C.N. has provided an NRM expert to assist these activities.

2.7 Pak Swiss Project for Horticulture Promotion (PHP).

Donors of the Project are the N.W.F.P. Government and the Swiss Development Corporation. Prior to the present phase (7^{th}) they were established only in Malakand Division and were known as the Malakand Fruit & Vegetable Development Project. As of July 2000 they are termed as the PHP. Their partners consist of the N.W.F.P. Research System and the Federal Seed Certification & Registration Department of the Federal Government. Their Regional Office is presently housed in the Potato Research Center situated in Mirpur, Abbottabad. One Group Support manager, one Assistant Support Manager and a single Finance Officer with some Administrative Staff are manning the Project. Marketing Officers (one each for males and females) are due to be appointed. The setup is charged with the promotion of the Horticulture Industry in Hazara Division. Previously they were associated with the Fruit & vegetable Development Board. They have recently associated with the Agriculture Extension Service of the Agriculture Department. The Project aims to achieve its objectives by:

a). Improving the supply of quality fruit plants and vegetable seed.
b). Introducing new horticultural techniques and enterprises on a pilot scale.
c). Exploring markets and exploiting marketing opportunities.
d). Strengthening institutions in both the private and public sectors.
e). Supporting horticulture policy development.

The PHP's major activities can be described as:

2.7.1 Fruit Nurseries: Here Private Nursery owners are assisted to raise Certified Planting Stock. One such nursery is situated on two kanals in Mangal, Abbottabad District. This nursery is carrying 2000 Certified RootStock that has been supplied on payment from Swat. Training and material has been provided by the PHP.

2.7.2 Vegetable Seed: In this case training is provided to local farmers through S.R.S.C. In 1999 farmers were assisted to grow Certified Onion Seed. This year, 2000, it is planned to assist farmers to grow Onion, Peas, Radish and carrot Seed.

2.7.3 ICM: Integrated Crop Management through sowing till marketing is the objective. Training is to be provided by foreign specialists. They will train Master Trainers who would then disseminate the training on to the local farmers.

2.7.4 Research: The PHP is involved in carrying out research on different vegetable varieties. This research is aimed at determining varieties that are best suited to:

a). Local markets.
b). High yields.
c). Local adaptability.
d). Disease Free.

These include, but are not restricted to the following:

a).	Cabbage.	29 varieties.
b).	Peas.	6 varieties.
c).	Onions.	13 varieties.
d).	Chilies.	4 varieties.
e).	Turnip.	4 varieties.

What can be considered as the core of the Project is the Germ Plasm Unit established at Mingora, Swat. Mother Plants have been imported from abroad and established. Bud wood and Graft wood seed is provided to farmers after certification from the FSC&RD. The Unit is inspected twice yearly for disease and duly certified.

The PHP plans to provide 1,00,000 certified fruit saplings to the NRCP for planting in the Galiyat area of Abbottabad district. They also plan to help the local Communities to establish two nurseries. Training and technical support will also be provided for the rehabilitation of existing orchards. Orchard Management training will also be imparted to the local communities.

3. MAJOR PROBLEMS:

3.1 Non availability of Fruit Nursery of good quality plants.
3.2 Shortage of water in some areas.
3.3 Lack of technical know how of modern Orchard and vegetable Management.
3.4 Diseases and Pest attacks.
3.5 Non availability of certified and true to type seed.
3.6 Very smallholdings.
3.7 Adulterated and expensive Pesticides.
3.8 Narrow range of varieties.

4. GENERAL THOUGHTS:

A vast majority of our population's diet is deficient in vitamins, minerals and proteins. Low intake of fruit and vegetables is perhaps the single major cause that contributes to this deficiency. The quality and quantity of fruit and vegetables grown in our Country leaves much to be desired. Low production against high demand causes price per unit to be beyond the reach of even the

middle class. The people living in the mountainous areas depend upon fruit and vegetables that are grown in the plains. Pesticides and also toxic emissions from vehicles increasingly contaminate these. The quality further deteriorates during transportation as plant nutrition does not serve to maintain shelf life. Secondly, packing and preservation is not up to the standards that should be applied. Even cheap vegetables thus undergo high transportation costs and further increases in price result. The Agri-Ecological and rainfall conditions in the mountainous areas are well suited to growing a variety of fruit and vegetables. There is a dire need of promoting these activities in order to enhance the nutrition of the populace. Secondly, a wide variety of off-season vegetables can be grown to meet increasing demands of markets around the entire Country. Produce such as Snow Peas; Chinese cabbage; Broccoli; Iceberg Lettuce; Artichoke; Asparagus; Celery; Apples; Walnuts and non-traditional varieties can find an increasing demand. The possibility of export is also very much present. It is essential to establish market linkages in order to tap this vast potential of economy generation and meeting the needs of the people. This would result in great socio-economic change by ensuring sustainable development with an equitable base.

5. RECOMMENDATIONS:

5.1 Fruit Sector:

a). Superior quality planting stock, which is the foundation stone for successful fruit production, should be provided to CBOs on manageable small scale.

b). Timely supply of inputs like Farm yard manure; fertilizer; adequate irrigation; tillage; and proper plant protection; should be ensured and available at Community Centers.

c). Continuos technical training should be provided.

d). Close linkages need to be developed with F&VDB; Research Institutions; Development Projects and NGOs working on Fruit Production.

5.2 Vegetable Sector:

Vegetables are high value crops and their cultivation for consumption or on commercial scales requires knowledge and skills. In order to ensure sustainable development the following approaches may be adopted.

a). Manpower Training: Short training courses as per requirement of CBOs on various related topics.

b). Raising of Vegetable Nursery Seedlings: Well-trained and progressive growers can raise nurseries of planting stock at Community level. Sale of seedlings should be facilitated through the Communities and later on the members can be encouraged to grow these seedlings themselves.

c). Vegetable Seed Production: Certified vegetable seed production may be carried out in dry and cool isolated areas, This activity may be carried out by farmers under the supervision of FSCRD. Seed production of onions can prove to be successful and very rewarding.

d). Home Kitchen Gardening: Emphasis should be upon locally grown vegetables with which people are already familiar or which are easy to grow. Okra; gourd; pumpkin and beans can be grown in Barani areas.

e). Off-Season Vegetables: Growing winter vegetables in summer where temperatures are mild to cool, can prove to be a very lucrative business. These areas have the added advantage of low pest infestation.

f). Research Linkages: FV&DB and research Institutions need to be involved in adaptive and applied research.[1]

6. FLORICULTURE:

6.1 Introduction: Flowers and ornamental plants are an ever-growing industry in today's world. Even Pakistan is seeing a "flowering" of this industry. The growth of flowers and ornamentals for both domestic and export markets, has a tremendous potential. Indeed it is recognized that a veritable economic revolution can be brought about by the industrialization of the horticulture sector.[2] The sale of cut flowers and ornamentals, potted plants, dried flowers and extraction of perfume oils are all part of the Floriculture sector of the larger Horticulture Industry. The moist temperate climate of Abbottabad District is very well suited to the propagation, multiplication and culture of a wide variety of flowers and ornamental plants. The period of November to May is the main potential season of supply to the Developed Countries (75 % of all imports received during these months).[3] Christmas (December) through Easter (March or April). Is the peak demand season for roses, tuberose and other flowers. The perfume industry has a year round demand for quality oil extract for various flowers. Indeed extract from the native wild variety of highly perfumed roses can be more expensive per gram than gold. Floriculture World Trade stood at US$ 3.644 Billion in 1987[4] and has since grown at a tremendous rate. The conclusion of the National Commission on Agriculture in 1988, suggested that Pakistan could achieve an export target of US$ 500 million in three years (1991) and US$ 4 Billion in 15 years (2003) provided that an "Industry Specific Package" of fiscal incentives is forthcoming. Unfortunately this did not take place. Even after the lapse of 12 years Floriculture is considered to be a very minor horticultural activity in the NWFP.[5] At present the wild Narcissus is perhaps the only flower being exploited commercially in Abbottabad District. Even the development of existing commercially sold flowers can make a high impact upon the rural economy. These are:

a). Roses.
b). Tuberose.
c). Jasmine sp.
d). Jasmine, yellow.
e). Narcissus.
f). Marigold.
g). Gladiolus.
h). Motia.

The wild tulip grows widely all over the District. This species is highly desirable in the European market. Gladiolus corms imported from Holland fetch 3 times the price of import within three months. However the plant with the greatest potential for wide scale development is the Rose.

The ornamental plants and their nurseries are another potential source for economy generation. The neighboring District of Haripur, with its less extreme winters, has seen a great boom in this industry. Exports and far and wide sales throughout the country are reported. Growing and

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[1] Major input by Qazi Mohib ur Rehman, Regional Manager, F&VDB, Hazara Division, Abbottabad.

[2] National Commission on Agriculture, 1988.

[3] Guidelines for Exporters of Cut Flowers to the European Market, Particularly U.K., MINFAL, 1993.

[4] UNCTAD.

[5] Floriculture Research And Development in the NWFP, Pakistan. ARP Phase II, OPCV & NESPAK.

protection of ornamental plants in Greenhouses can flourish in Abbottabad District. The active tourist traffic and summer residents of affluent backgrounds can prove to be a source of buyers in the domestic market. Export can be developed to a large extent. Plant species that can make a good start are:

a). Araucaria.
b). Bougainvillea sp cycads.
c). Hibiscus varieties.
d). Magnolia.
e). Ferns.
f). Succulents and Cacti.

6.2 Problems: The attendant problems that are inhibiting the spread of the Floriculture Industry may be summarized as:

a). Lack of knowledge.
b). Lack of reference and resource material.
c). Lack of research.
d). Lack of training.
e). Lack of skills.
    a). Bed preparation.
    b). Potting mix preparation.
    c). Planting.
    d). Propagation.
    e). Care.
    f). Harvesting.
    g). Processing.
    h). Packing.
    i). Plant management in protected environments.
f). Lack of support.
g). Lack of Plant Breeder Rights Legislation.
h). Lack of mother plants/ planting stock.
i). Limited access to markets and market information.
j). Lack of storage facilities.
k). Lack of credit.
l). Lack of export assistance/ long and complicated procedures.

6.3 Tissue Culture: As mentioned a Tissue Culture basic facility exists in Mirpur, Abbottabad in the shape of the Potato Research center. It can very easily be expanded/ improved to include tissue culture work in ornamental plants. Tissue Culture would cater to the production of disease free plants, rapid propagation and the long-term storage of plant tissue. It would act as a long- term repository for new and endangered species. It is an important tool for genetic engineering that is fast becoming the technology of tomorrow. The following extremely significant quotation should be noted:

"The tissue culture program would enable the introduction of a wide range of ornamental germplasm in tissue culture from laboratories throughout Pakistan and from leading World Centers. Through the application of rapid micro propagation and modern nursery practices, a significant and most valuable collection of floricultural plant species and cultivars can be quickly

assembled in the Province. This collection would form the foundation stock by which a new and floriculture (cut flowers and ornamental nursery plants) industry in the NWFP can be initiated.[1]

6.4 Low Cost Initiatives: It is not necessary to go in for high cost structures and equipment. Our resources and present economic condition do not allow for such luxuries. However, there exist a number of low cost alternates that can be adapted for use in the Floriculture Sector. One such intervention is the "Wah garden". This is a low cost plastic film, environment protected, sub-soil irrigated, compost bed structure for the growing and protection of vegetables, herbs and flowers/ ornamental plants. The concept has been borrowed and adapted from the Australian technique of "Permaculture" The structure has recently been demonstrated in Haripur, Manshera and Abbottabad Districts. The SRSC is actively pursuing the technique and experimentation regarding photo-period and heating control is due to begin at their Regional Headquarters. The use of natural rooting and fruiting hormones (registered with EPA, USA) and complete foliar fertilizers (major, secondary and micronutrients) will ensure healthy and fruitful plants. These measures will afford poor and small subsistence farmers and women folk with the opportunity to go in for income enhancement through the following:

a). Year round production of all horticulture species.
b). Off-season production.
c). Optimum and controlled conditions for production of high quality plants.
d). Protection of Mother Plants.
e). Screening from external sources of disease/ infestation.

It is surprising that a great deal of automation and control can be obtained through the use of recycled and innovative items. Careful thought and experimentation has led to the emergence of a number of such alternates/ innovations.[2]

6.5 Training: The Training of Trainers that would initiate and nurse the Floriculture Industry should include the following:[3]Green house principles in design, structure and operation.

a). Potting mixes and the nutrition of plants.
b). Simple and routine analytical procedures for potting mix.
c). Plant health, pest and disease control.
d). Regulation of plant growth through environmental manipulation.
e). Identification and classification of ornamental and herbaceous plants.
f). Propagation methods for woody and herbaceous plants.
g). Production methods for bedding plants.
h). Collection, storage and testing of seed.
i). Irrigation methods for potted plants.
j). Tissue culture of floriculture plants.
k). Domestication (as potted plants or cut flowers) of indigenous plant species.

The climate and topography of Abbottabad District provides a unique opportunity to select, develop and commercialize native plant species. This is also necessary due to uncontrolled grazing and rapid depletion of naturally occurring plant species. Research needs to be carried out in this sector before valuable genotypes are lost forever! This research and protection/ propagation should not be restricted to the floriculture sector but should include all native

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1 Floriculture Research And Development in the NWFP, Pakistan. ARP Phase II, OPCV & NESPAK.

2 Khidmat Foundation, Pakistan. Adaptive & Applied Research & Development NGO for Rural Development.

3 Floriculture Research And Development in the NWFP, Pakistan. ARP Phase II, OPCV & NESPAK.

species especially medicinal plants. This is only possible in a flourishing and expanding economy. This target can be achieved through the patronage of floriculture as one of a number of interventions that can tap the vast potential of Abbottabad District.

6.7 EXPORT: Imports of cut flowers into the European market are affected by various regulatory requirements.

6.7.1 Quality standards. EC Common Quality Standards for Fresh Cut Flowers and Foliage are reported on as follows.

a) Phytosanitary Regulations.
   a) Roses.
   b) Carnations.
   c) Chrysanthemums.
   d) Gladioli.
   e) Gypsophila.
   f) Statice.

b) CITES Requirements: Convention on International Trade of Endangered Species of Wild Fauna and Flora.

c) Import and CAP Licenses.
   a) Roses.
   b) Carnations.

d) Classification and Quality Requirements.

   i. Class I:
      a) Whole.
      b) Fresh.
      c) Unbruised.
      d) Free of animal and vegetable parasites and from resultant damage.
      e) Free of residue of pesticides and other extraneous matter affecting the appearance.
      f) Free of development defect.
      g) According to species, stems must be rigid and sufficiently strong to support the flower(s).

   ii. Class II.
      a) Whole.
      b) Fresh.
      c) Free of animal parasites.

      The following defects may be present provided they do not impair the appearance, life or use of the flowers.
      a) Slight malformation.
      b) Slight bruising.
      c) Slight damage, including that caused by pest or disease.
      d) Small marks resulting from pesticides.
      e) Weaker and less rigid stems.

   iii. Quality Tolerances.

      Class I.
      a) Up to 5 % of the cut flowers may have slight defects provided the uniformity in a unit of presentation is not affected.

      Class II.

a) Up to 10 % of the cut flowers may vary from requirements of the Class. However, not more than half of this 10 % may be damaged by animal or vegetable parasites. The defects in question must not impair the use of the flowers.

iv. Table 10: Sizing.

Description Code.	Minimum and maximum Stem Length.
5	5 - 10 cm
10	10 - 15 cm
15	15 - 20 cm
20	20 - 30 cm
30	30 - 40 cm
40	40 - 50 cm
50	50 - 60 cm
60	60 - 80 cm
80	80 - 100 cm
100	100 - 120 cm
120	More than 120 cm

v. Uniformity of Sizing. In any one unit of presentation (e.g. bunch, bouquet or box, etc.) The maximum permitted difference between the shortest and longest stem lengths is as follows:

Table 11: Permitted Difference.

	Description Code.	Stem Length
For stem lengths < 20 cm	0 - 15	2.5 cm
For stem lengths 20 - 60 cm	20 - 50	5 cm
For stem lengths > 60 cm	60 & over	10 cm

6.8 Roses: This King of flowers also has a religious significance for Muslims. As such it can easily be adapted and used for commerce. Some form of protection is required from frosts, unless frost resistant varieties are used. Roses do well on slightly acidic, neutral or slightly alkaline soils on pH ranging from 6 to 7.5. Proper soil management is essential to rose production. A well-balanced fertilizer containing NPK as well as iron, zinc and magnesium will yield good results on almost any soil. Increased Organic Content will keep the pH within manageable limits. Foliar applications will overcome tying down of nutrients. Roses are the major cut flower of the World. They can be grown as long stemmed cut flowers, miniatures, posies, flowers for garlands, petals for sale, extract for perfume industry. Some of the varieties in demand are:

6.8.1 Cultivars: Specially bred 'green house roses' of Rosa X hybrid.

a). Large flowered Hybrid Tea, 60 to 80 mm stems.
b). Medium flowered Hybrid Tea, 50 to 70 mm stem.
c). Small flowered floribunda, 40 to 50 mm stem.
d). Spray Roses.

6.8.2 Cutting & Pinching. The calyx is that portion of the rose flower that is left behind when all the petals have been shed. It is necessary to pinch off this portion of the flower. This helps to shape up the plant as well as prevents the flow of nutrients towards seed production. Instead these nutrients are directed towards producing new blooms. The quality of the flowering on the plants depends upon where the plant is pinched. Close examination of the plant will reveal that

there exist some pointed buds at the base of certain leaves immediately below spent blooms. If the plant is pinched immediately above a pointed bud a short stemmed bloom results. On the other hand, pinching immediately above a rounded bud results in long stemmed blooms. It is important to note that the pointed buds are borne in the axil of three leaflet leaves and rounded buds are borne in the axil of five leaflet leaves.[1]

Figure 1: Distribution of bud types on a rose flowering shoot.

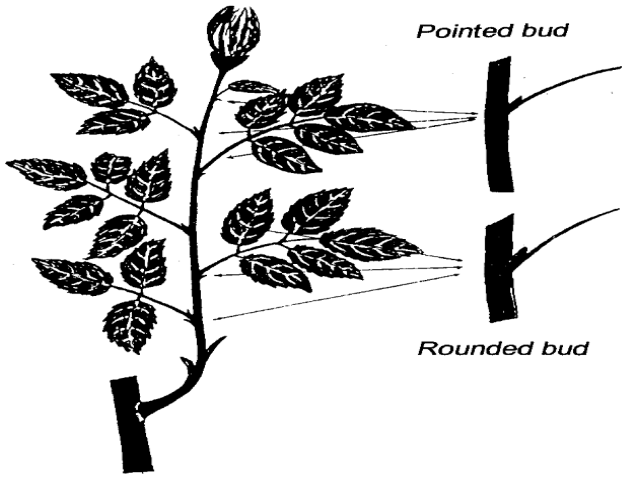


Figure 2: Cutting System:

(A) (B) (C)

System of cutting for various caliper shoots. (A) Thin shoot from thin shoot; cut under the hook. (B) Thin shoot from thick shoot; cut at the knuckle. (C) Thick shoot from thick shoot; cut above the hook, leaving one good five-leaflet leaf.

[1] Profile on Rose Culture in Pakistan, AgriBusiness Cell, MINFAL, 1993.

6.8.3 Companion planting is particularly useful in the case of Roses. Many pests and diseases are avoided by this procedure. The plants that can be planted in companion to roses and which provide maximum benefit are:

a). Garlic, The effect of garlic upon the fungi that cause black spot is reputed.

b). Parsley, said to repel pests.

c). Onions, provides the rose plant with sweeter scent.

The use of a decoction of tobacco is effective against aphids, hairy caterpillar and the chafer beetle and wold. It is also effective against termites.

6.9 Dried Flowers & Foliage:

Roses, hydrangeas and some form of daisies can be readily dried and sold commercially. These plants can be grown and processed in rural areas and would provide increased income. Due to keeping qualities the associated marketing and transportation problems are lessened to a great degree. Dark airy rooms that are free from sunlight and dust are the best drying places for flowers. The flowers are simply hung from the roof.

6.10 Flower Oil Extraction:

This is a very lucrative potential market with possibilities of high returns. It is a micro industry and can be established in the rural areas. Mint, Lavender and Roses are some of the possible plants for exploitation. Once again ease of storage and transportation does away with most of the problems associated with fresh flowers industry.

7. WATER CONSERVATION FOR HORTICULTURE:

7.1 A Nepalese Model of Simplified & Low-cost (SLC) Drip Irrigation Technology.

7.1.1 Background & Introduction: Drip or Trickle irrigation is regarded as the most water saving irrigation technology so far. There are several advantages of drip irrigation over other commonly used irrigation methods. Conventional drip irrigation was originally developed in Israel in early 50s. It was later widely adopted in other countries like USA, Australia & Europe etc. Most countries adopting drip irrigation are the developed ones. The main factors for slow adoption or non-adoption of conventional drip irrigation in developing/ underdeveloped countries are:

a) Relatively High Capital Investment Cost.

b) Complex Irrigation Management Process.

7.1.2 International Development Enterprises, an INGO in Nepal has developed a low cost drip irrigation technology that is appropriate to micro plots (less than 1 acre). The design was developed & tested by simplifying the conventional drip irrigation technology with some modifications. The main modifications are:

a) Shiftable Drip lines (One drip line for several rows)

b) Change to a low-pressure system (1 to 2 M)

c) Simple Filtration System

d) Simple & inexpensive fittings

e) Easily understandable system.

7.1.3 For the past 4 years, IDE/ Nepal is implementing the Drip Irrigation Program in some Hill districts of Nepal targeting poor and marginal farmers. NGOs & private entrepreneurs are the main collaborating organizations in the program. Technology is made available to the farmers through local dealers who purchase from Technology Assembler /Distributors. IDE & NGO partners help develop marketing system of the technology. They also provide technical support that includes drip installation /management & training on agricultural know-how. Drip irrigation has been applied mostly for high value vegetable crops.

7.1.4 Drip irrigation is made into package of 3 standard sizes viz. SMALL, MEDIUM and LARGE (to irrigate 125, 250 & 500 Sq. m respectively). Depending on the field size & shape, field lay-out can be done out of the two standard designs DESIGN-A or DESIGN B. The user's price (not subsidized) is about US $ 13 for SMALL system. Similarly it costs $19 & $32 for MEDIUM and LARGE systems. IDE has trained technicians at local level to properly install systems & advises users about the technology.

7.2 The system broadly consists of the following components. (It will be easily understandable if this is read in conjunction with the attached drawings)

a) Head Unit (Tank and Filters)
b) Pipe System (Main Pipe, Adjuster, Drip Pipe & Vent Pipe)
c) Fittings, & others.

7.2.1 Head Unit: This comprises a 50-L water tank integrated with filtration system. There are 3 types of filters (Foam, Coarse Screen & Jerry can/ Net) attached to the tank. The tanks also have outlet and overflow arrangements.

7.2.2 Pipe System: Functionally there are three types of pipes used in the system. All of them are made of PVC soft material. Main pipelines (dual lines) connect the Tank outlet to the bifurcation point of the drip pipe. Its diameter is 13 mm.

a) A small piece of pipe called Adjuster is provided between Main Pipe and Drip Pipe so as to facilitate shifting of drip lines. The adjuster is further connected with Drip pipe or Lateral, which has accurately punched holes at every 60 cms. The ends of pipes are closed with end plugs. The diameter of both Adjuster and Lateral is 8 mm.

b). To remove air in the pipe and also to observe the level of water inside the tank, 60-cm. long transparent tube is attached with the Multi connector near the outlet point.

7.2.3 Fittings: The following pipefittings are used in the system to connect various points.

a). Nipple /Nut with a pair of Washers: For outlet, and Overflow points in the tank.
b) Adopter: To connect Jerry can Filter with the Outlet (Inside the Tank)
c) Multi: To connect Outlet with Main Pipelines. This has 3 branches, 2 for Main lines and 1 for Vent Pipe.
d) Gate Valve: To Run & shut down the water flow in the pipe system. There are two Gate Valves in the system, one for each Main line.
e) Tee: To connect Adjuster from Main line.
f) Connector: To join Adjuster and Drip Line.
g) End Plug: To close the Dead ends of the pipe.
h) Pegs: To better hold the Drip pipes and ease the pipe shifting process. There are 2 pegs at either end of the drip pipe.
i) Baffles: As the name indicates, Baffle is the component to break (lie spraying of water out of the drip holes. As such baffles are snapped at each dripping point i.e. 60-cms. spacing. Baffles should not be taken out to prevent breakages. However, they can be moved sidewise to observe and de-clog the drip holes in case they are blocked.
j) Safety Pin: This item is included in the package so as to clean the drip hole in the events of plugging.
k) Jute thread: To ensure the correct line during preparation of crop beds.
l) Jute Rope: To tie the superstructure for placing the Tank.

7.3 Materials & Tools: The following materials & tools are necessary before installation:

Table 12: Materials required before Installation:

Sr	ITEM	Quantity

1	About 2 meter long bamboo or wood	3 pcs.
2	About 1 m long bamboo or bush battens	5 pcs.
3	Water.	Few Buckets.
4	Spade, Sickle, Pit Making tool.	1 each.
5	Transplants / Seed.	As per plot size.
6	Fertilizers,	As suggested by Agri-Technician.
7	Package of Drip System.	1 Bag.

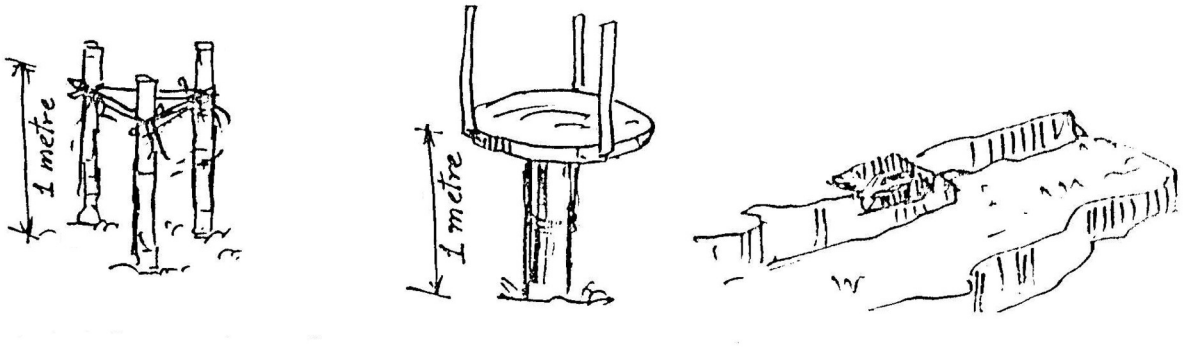


Figure 3: Pre-Installation Equipment:

7.4 Installation Process: Following step by step process is suggested to properly install the SLC Drip System.

a). Chose the right design out of 2 designs depending on your plot size and shape. For larger plots adopt DESIGN - B while for smaller ones DESIGN - A could be more appropriate. Make sure that in no case the length of the lateral exceeds 12 meters.

b). Having chosen the DESIGN, make the plots as shown in the drawings. A bed width of 90 cm with 20-cm wide channel in between the beds is recommended for usual vegetable crops.

c). Decide the position of Head Tank and make the structure for it. Ideally, the tank should be located in the mid-edge of the field as shown in the drawing. The platform of the tank should be approximately 1 meter from the highest point of the crop field.

d). The tank also can be placed on the ground if it is a rolling or terraced land and the head conditions are appropriate.

e). Fix the Tank fittings - Outlet Set, Overflow Set, Jerry can Filter & Foam Filter. Keep the Tank on the platform.

f). Attach Multi Set (Multi with Vent pipe & Gate Valve) at the Outlet Nipple.

g). Connect Main line with Gate Valve.

h). Mark the points of Tee connection. For a coverage rate of "One line for 2 Beds" the place of the tee becomes every alternate channel as shown in the figure. Cut the Mainline Pipe at tee connection points.

i). Connect Adjuster Set (Tee, Adjuster, Peg & Connector).

j). Unroll the Drip pipe and cut at the required length (approx. length of crop bed) after measuring different beds.

k). Insert pegs at ends of laterals. Close the dead ends of pipes with end plugs (Both Main Line and laterals). Keep the laterals almost straight along the proposed plant row.

l). Fill the tank with water. It is good to clean tie tank before placing into platform. Open the dale Valve and let the water drip for few minutes. Close the gate valve. Shift the lateral into next proposed row and again let the water drip by opening the Gate valve.

m). Mark the spot of wet places by digging small pits.

n). Dig the pit of required size and mix fertilizers. Allow sufficient time before planting after mixing fertilizers.

o). When it is ready for transplanting or seeding, run the system again and finalize exact planting spots. Put your plants /seeds at the dripping points.

7.5 Management Guidelines of SLC Drip System:

7.5.1 Basic Preparation: Make sure that:

a). You have water to put into tank.
b). Dripping points are at correct places i.e. close to the plants.
c). The ends of the pipe are not open.
d). Filter is clean & there is no debris left.
e). All joints are in good working order (absence of faulty & disconnected joints).

7.5.2 Irrigation:

a). Keeping the Gate Valve closed, fill the tank up to ¾ inch height.

b). Open the Gate Valve & irrigate. After a while, water should drip from each dripper. Clean the dripper by jarring with fingers. If necessary insert & pull safely pin into the hole. If several holes are found clogged at the same time the pipes should be flushed by opening the end plugs.

c). Irrigation duration & frequency: This depends on large number of factors. However, as a rough guide the following recommendations are made:

Table 13: Irrigation Data.

1st Month of Plantation			Flowering/ Fruiting Stage	
ETO mm/ day	Duration	Interval (days)	Duration	Interval (days)
3 – 5 mm	10 minutes	Every Day	60 minutes	4 days
5 – 8 mm	15 minutes	Every day	90 minutes	4 days

7.5.3 Note:

a). Irrigation should be more frequent in sandy soils
b). If it rains the interval & duration of irrigation should be fixed based on soil moisture status.

3) Regular Maintenance works:
   a). Filter cleaning (All filters) looking at the filter condition.
   b). Cleaning plugged holes.

7.5.4 Storage:

At the end of crop season, the system components should be cleaned. In the rainy season it should he stored properly and reactivated at irrigation time.

7.5.5 Some Important points:

a). The drip system, whether in the house or field, should he protected from animals & curious
b). Children. It is thus good to have some fence around the drip plot.
c). Never keep the open ends of pipes in contact with soil/ dirt.
d). The drip hole should be just below the interior channel of the baffle.
e). Every care should be taken while shifting the drip pipes.

Figure 4: Components.

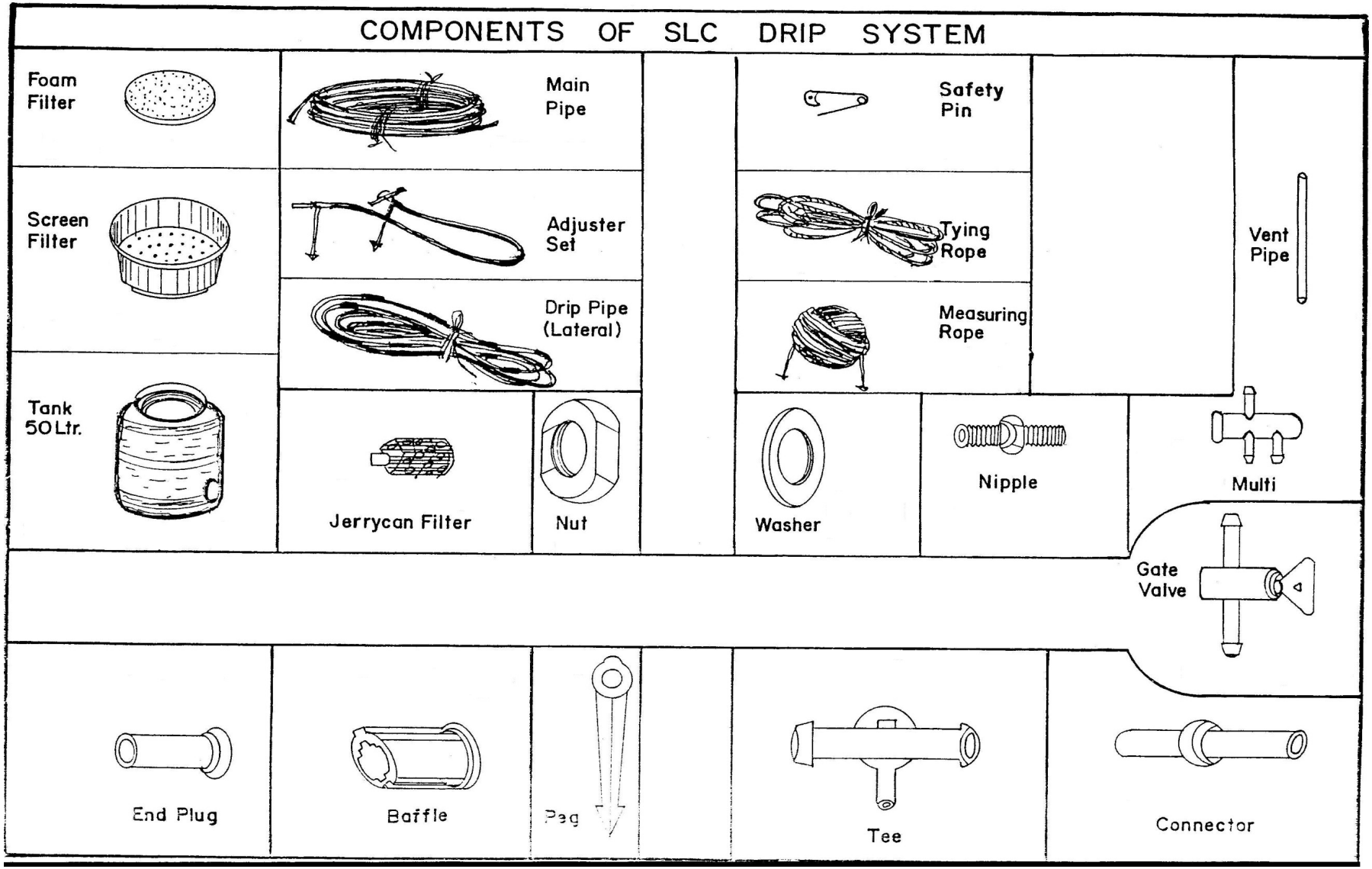


Figure 5: Design A.

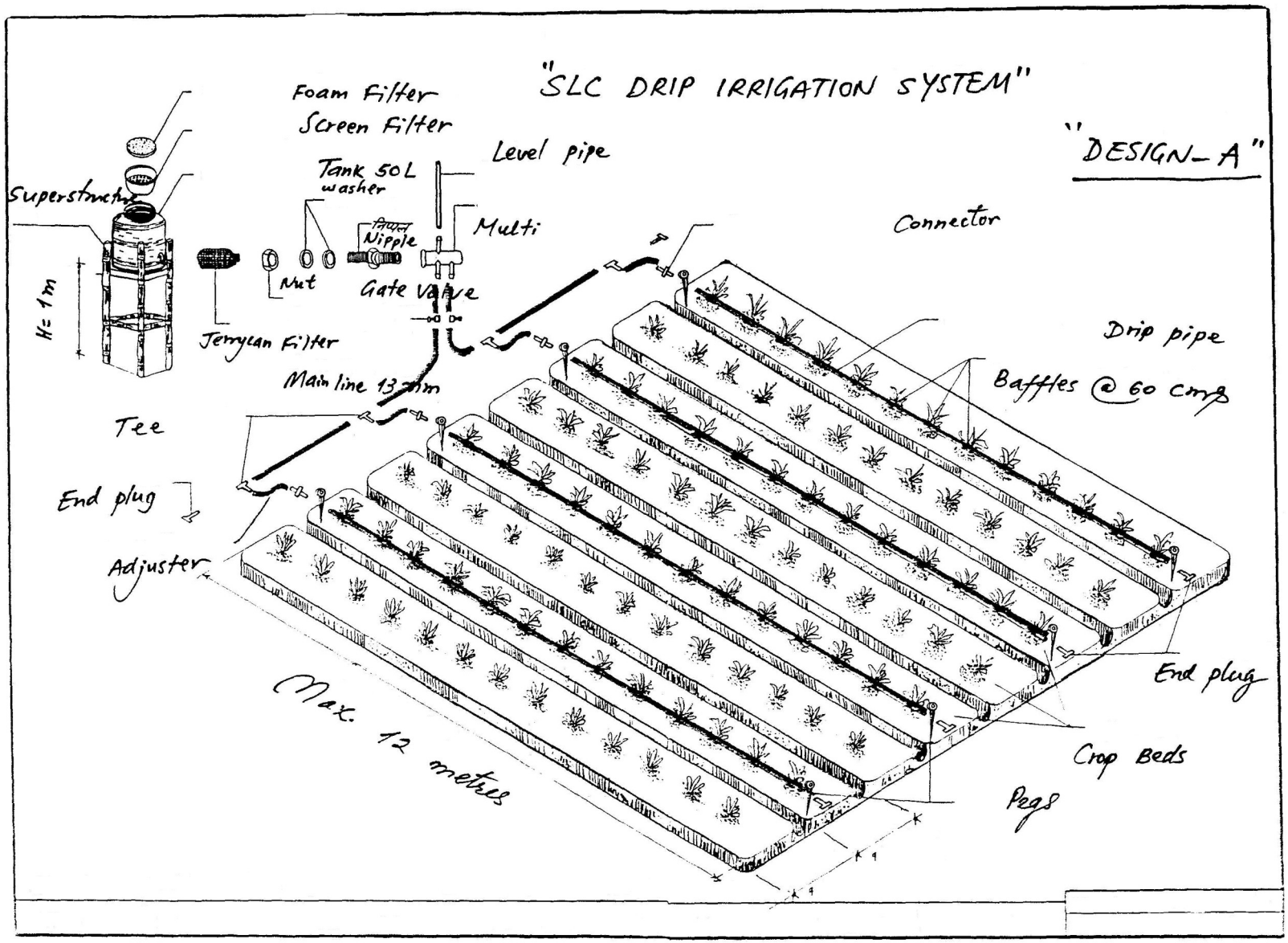
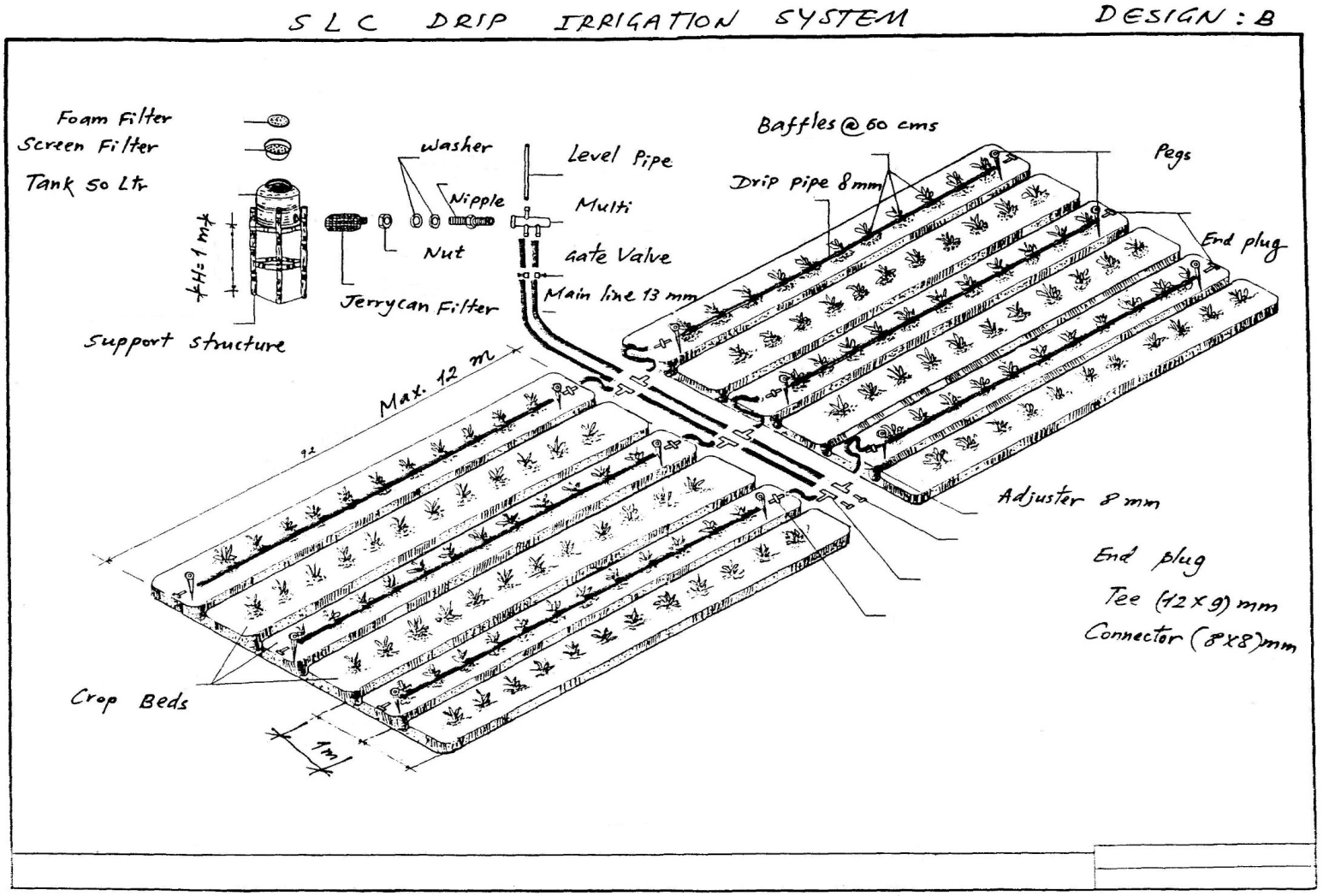


Figure 6: Design B.



8. FRUIT: Abbottabad District is blessed with a variety of fruit, however, quality and quantity remains poor at best. This is due to serious misunderstanding about Plant Nutrition and lack of cultural skills in fruit growers. Extension has failed to reach our fruit growers, this has resulted in poor grade fruit. There is tremendous scope of both vertical and horizontal increase in fruit production. Vertical increase through demonstrated excellence will serve to encourage our farmers to go in for more and varied planting of fruit crops. Nutritional values and cost effectiveness are the two major arguments in favor of increasing fruit production. Processing and packing combined with Community Based Marketing & Export will serve to take positive charge of additional production. Value added processing and canning will serve as a tremendous boost to the meager incomes of our subsistence farmers.

6.1 Table 14: Tolerance of Plant Foliage to Urea Spray in Kgs. per 380 L of Water.

#	PLANT	Tolerance (Kgs).
1	Apples, Grapes, Strawberry, Apricot, Pear.	2 – 3 Kgs.
2	Citrus, Lemon.	2 – 5 Kgs.
3	Plum.	2 – 7 Kgs.
4	Cherry.	2 – 9 Kgs.

6.2 Table 15: Number of Trees or Plants on an Acre.

SPACING	**NUMBER**	**SPACING**	**NUMBER**
1 X 2	21,780	6 X 6	1,210
1 X 3	14,520	6 X 8	907
1 X 4	10,890	8 X 8	680
1.5 X 2	14,520	10 X 10	436
1.5 X 3	9,680	12 X 12	302
2 X 3	7,260	15 X 15	194
2 X 4	5,445	16 X 16	170
3 X 4	3,630	18 X 18	134
3 X 5	2,904	20 X 20	109
3 X 6	2,420	25 X 25	70
4 X 4	2,722	30 X 30	48
4 X 6	1,815	40 X 40	27

8.3 Orchard Rehabilitation: It has been observed that most of our Orchards are not provided with adequate nutrition. Secondly, cultural practices leave much to be desired. This includes pruning, thinning, spacing, cultivating and watering. All this leads to poor quality fruit, reduced yields (abscission), poor shelf life, alternate bearing and diseased trees. In such a situation the economic benefits of maintaining an Orchard are severely curtailed. Proper training and demonstration as well as provision of nutrients can dramatically effect the Orchards. Grade A, exportable surpluses can be achieved and some of the economic woes of the Nation can be addressed. About 200 % increase in yields, both in terms of quality and quantity has been observed with proper care. Tip die back and fruit fly infestation have been cured through correct nutrition. Nutrients that are safe and stabilized have been discovered. These are registered with the Environment Protection Agency of the United States and are being formulated in Pakistan. They are safe to use for the atmosphere, the soil, the plants and the users. Again the present method of flood irrigation is both wasteful and damaging. Aeration is reduced and water borne pathogens find a convenient entry point. Conservation and ring basin irrigation is recommended.

Figure 7: NPK for Fruit.

ORGANIC/ MINERAL FERTILIZER REQUIREMENTS FOR VARIOUS FRUIT TREES:

	AMMONIUM SULFATE				SSP				SOP				FARM YARD MANURE				
Age	1 - 2	2 - 5	5 - 10	Over	1 - 2	2 - 5	5 - 10	Over	1 - 2	2 - 5	5 - 10	Over	Plant	1 - 2	2 - 5	5 - 10	Over
Citrus	1	2	4	6	2	2	3	4	1	1	2	2	20	10	15	50	80
Guava	1/2	1	2	2	1/2	1	2	2	-	1/2	1	1	2	10	20	40	50
Apple	1/2	2	3	3	1/4	1.5	2	2	-	-	1	1	10	-	20	25	25
Apricot	1	4	5	6	1	2	3	4	1	1	2	2	40	-	20	20	20
Peach	2	3	4	5	1	2	3	4	1/2	1	2	3	20	-	20	20	20
Plum	1/2	1/2	1	2	1/4	1/4	1/2	1	1/2	1/2	1	3	30	-	20	20	20
Pear	1	2	3	5	1/2	1	2	3	1/4	1/2	3/4	2	30	-	20	20	20
Almond	1	1	2.5	3	3/4	3/4	1.5	2	1/2	1/2	1	1.5	40	-	30	30	40
Walnut	2	4	6	8	2	3	5	6	1	2	3	3	40	-	50	30	40
Grape	2	3	4	5	2	4	6	7	1/2	1/2	3/4	1	20	20	20	60	80
Cherry	2	3	4	5	1	2	3	4	1/2	1	2	2	20	-		30	40

Farm yard manure (in tons/acre) should be added in December. All Single Super Phosphate and Sulfate of Potash and half dose of Ammonium Sulfate should be added two weeks before flowering or by mid February. The remaining Ammonium Sulfate should be added after fruit set. Mineral Fertilizer is shown as bags of 50 Kg.

6.3 Table16: Effects of Various fertilizers on the pH of the water and Soil:

	pH Increase	No effect on pH	pH decrease
Ammonium Nitrate			XXX
Potassium Nitrate	XXX		
Mono Ammonium Phosphate (MAP)			XXX
Diammonium Phosphate (DAP)	XXX		
Calcium Nitrate	XXX		
Sodium Nitrate	XXX		
Ammonium Sulfate			XXX
Ammonium Chloride		XXX	
Urea	XXX		
Potassium Sulfate (SOP)		XXX	
Potassium Chloride		XXX	
Mono Potassium Phosphate			XXX
Magnesium Nitrate			XXX
Magnesium Sulfate			XXX
Phosphoric Acid (Liquid)			XXX
Calcium Sulfate (Gypsum)			XXX
Calcium Chloride			XXX
Sulfuric Acid (Liquid)			XXX

6.4 Fruit Shedding:[1] Fruit shedding can be caused by drought, injury, a shortage of carbohydrates or a deficiency of certain nutrients such as Calcium, Potassium, Boron and Zinc.[2] All of these conditions effect the hormonal balance of the plant, which, in turn, regulates the enzymes that weaken the cell walls in the separation layer. Ethylene and Abscisic Acid, ABA, causes the shedding of leaves and fruit, while Auxins vent or decrease shedding. The balance of these plant hormones determines whether a leaf or fruit will shed or remain on the plant.

6.4.1 Carbohydrate Shortage: Research has shown that a carbohydrate shortage increases ethylene production and decreases auxin content of young fruit. A shortage can be caused by a decrease in photosynthesis, an increase in respiration or a heavy fruit load. Low light intensity is probably the most common cause of a decrease in photosynthesis. Cloudy weather or crowding of fruit plants can result in low light intensity, a decrease in photosynthesis and excessive fruit shedding. Humidity and rain that accompany cloudy weather cause leaves to grow larger. This can cause too much shade if the plants are too close together. If this happens the plants exhibit a tendency to grow tall and rank in a race with each other to get out of the shade and into sunlight. Clouds cannot be controlled but crowding can be limited by avoiding a plant population that is too high for the conditions that prevail. This depends upon soil fertility, soil water content and the variety being grown.

6.4.2 Drought: This causes increase in ethylene production, increases ABA content and decreases auxin content. Each of these hormonal changes causes fruit shedding. Drought also decreases photosynthesis, which also increases shedding. If irrigation is to be inhibited to avoid vegetative growth, it should be done before flowering and before there is any fruit to shed. Older fruit are not likely to shed, this is the time when irrigation can be curtailed.

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1 Dr. Zia Javed Ph.D., Stoller Pakistan (Pvt) Ltd., 1999.

2 Western Cotton Research laboratory, U.S.A.

6.4.3 Injury: Injury increases ethylene production and therefore, may cause shedding. Insect feeding and egg laying are common causes of injury and shedding. Leaf feeding insects can cause shedding by decreasing photosynthesis. Spider mites appear especially damaging in this respect.

6.4.4 Nutrient Deficiencies: Potassium, Calcium and Boron deficiencies are especially likely to cause shedding because these elements are necessary for translocation of carbohydrates. Therefore, a deficiency of any of these elements causes starvation and shedding of flowers and fruit. Fruit shedding is triggered by ethylene production by the plant in the area of abscission. Ethylene production is caused by localized Calcium deficiency in the area of abscission. Many crops can tell us if they have localized Calcium deficiencies. For instance Apples get "bitter pit". localized Calcium deficiencies occur during dry periods. When rainfall is received or irrigation is applied the plant begins to grow vigorously. Shortly, thereafter Calcium deficiencies occur. This is due to the fact that plants cannot store Calcium nor is it mobile within the plant. Thus plants need a constant supply of Calcium, no other nutrient has these properties. When localized Calcium deficiency is recognized it can be made up with foliar applications. There are certain myths about Calcium and these must be laid to rest:

a). Calcareous soils have enough Calcium. Supplemental Calcium is not needed. Blossom end rot in cucurbits is exhibited in high calcium soils.

b). Limestone provides adequate Calcium on acid soil. Yet Calcium problems are still present.

c). Localized Calcium deficiencies cannot be controlled by applying Calcium.

d). Extra Nitrogen is harmful even if adequate Calcium treatments are used. Therefore we are limited to the amount of Nitrogen that we can use.

e). Only certain crops have problems with localized Calcium deficiencies.

Zinc deficiency also causes shedding. Zinc is necessary for the production of auxins. A deficiency will result in mottled leaves, short inter-nodes and shedding. Heavy load shedding is a cause of shedding that can be lived with. Thinning of fruit can, however, limit this type of shedding.

8.5 Fruit Cracking: Fruit cracking occurs when a dry period is immediately followed by a wet period. During the dry period leaves continue to loose water to the air. Moisture is pulled out of the fruit into the leaves causing deficiencies of both Calcium and Boron. Cells within the fruit continue to develop during this period of Calcium deficiencies. They also continue to accumulate sugars (soluble solids). When water becomes available either from rain or irrigation it rushes to the fruit. The higher the soluble solids (sugars) in the fruit the more the water that rushes into it. This is why mature fruit are subject to cracking. When cell walls are weak due to lack of sufficient Calcium and Boron, cracking is more severe. The only safeguards against fruit cracking is continuous spraying of Calcium and Boron as well as ensuring a plentiful water supply. Increase of Potassium in soils that continually exhibit this problem will help retain moisture. Compost addition will also alleviate this problem.

8.6 The Model: When crops are actively growing, the roots are actively respiring (breathing out carbon dioxide). If moisture is limited, carbon dioxide forms bicarbonates at the root hair surface. This layer of bicarbonate continues to get thicker. It inhibits the uptake of Calcium by the roots. The problem is increased by precipitation of Calcium by Phosphate in high phosphate soils. As Calcium uptake decreases, the rate of photosynthesis decreases. Most of the Calcium that is absorbed moves directly to the top of the plant. It follows the transpiration stream of water in the xylem tissue. Once it gets to the plants top, Calcium movement is terminated, it can not move downwards in the pholem tissue. In addition to this restricted movement, any excess

Calcium that is not needed in the plant top is quickly precipitated to Calcium Oxalate. Therefore, a continuous supply of Calcium is needed. The interruption of Calcium absorption by the roots causes severe Calcium deficiencies in the plant. The most seriously affected areas of the crop are the lateral branches or the vines. In other words, the plant parts that have less water supplies (transpiration) will be the parts most severely affected by localized Calcium deficiency. When the crop receives additional water either through rainfall or irrigation, the bicarbonate layer around the root hairs is reduced. The plant, once again, receives a greater supply of all nutrients and vegetative growth increases rapidly. It is during this period that localized Calcium deficiencies become more apparent. Localized calcium deficiency causes deficient areas to produce more ethylene. It is this excessive supply of ethylene that causes fruit shedding (called abscission). It can also cause cell collapse of fruit tissue and storage tissue of leaf tips. It can also cause seed abortion. If all plant parts had adequate supplies of Calcium on a continuous basis, cell walls would be more resistant to ethylene attack. In summation the following are the conditions that promote localized Calcium deficiency.

a). Dry soil (less Calcium uptake and distribution).
b). Followed by rapid growth.
c). High Nitrogen levels in the plant.
d). High interference of Calcium uptake by Mg++, Na+, K+ and NH4+.

8.6.1 Treatment: There are two methods of correcting and/ or protecting the crop against localized Calcium deficiency by application of calcium:

a). Soil application.
    i Band application: Band Calcium and Nitrogen together. Nitrogen should be in Ammonium form. Ratio of N:Ca should be approximately 3:1. Use a Nitrogen inhibitor to encourage the Nitrogen to stay in the Ammonium form. The large concentration of calcium in the root zone will keep an adequate supply to the roots even in the presence of high bicarbonates.
    ii. Irrigation water: Supply Nitrogen and Calcium through the whole growing period. Since irrigation water dilutes Calcium in the soil volume, a continuous supply is needed, the ratio should remain at 3:1.
b). Foliar application.
    i Ammonium Nitrogen stabilized with Nitrogen inhibitor can be alternated with a Calcium and Boron spray.

8.7 Fruit Trees Nutritional Program:

8.7.1 Purpose:
    a). To control shoot growth.
    b). To increase disease resistance.
    c). To increase yield.
    d). To increase size of fruit.
    e). To improve storage quality of fruit.

8.7.2 Program:
    a). Post harvest:
        i Spray 50 mL of N inhibited Nitrogen per Liter of water on the trunk and as much woody tissue as possible. Spray immediately after harvest and ensure that the trunk and woody tissue is thoroughly wet but not dripping. Do not spray 4 weeks before flowering.

ii Inject 0.5 Kgs. Urea stabilized with 0.5 Kgs. calcium Chloride per mature tree at 5 – 8 places around the drip line, 4 inches deep.

b). Add Mineral Fertilizers and Compost/ Farm yard manure as per specified amounts depending upon variety and age.

c). Spray before flowering and at fruit set followed by 10 – 15 day intervals for a total of 5 sprays. Use Complete Micro Nutrient formulation (5 mL/ L water), an example would be:

i	N.	5.00 %
ii	P2O5	18.00 %
iii	K2O	2.00 %
iv	Mg	0.40 %
v	S	2.00 %
vi	B	0.10 %
vii	Co	0.05 %
viii	Cu	0.10 %
ix	Fe	0.40 %
x	Mn	0.40 %
xi	Mo	0.05 %
xii	Zn	0.80 %

add an equal amount of Calcium & Boron,

i	Ca	6.00 %
ii	B	2.00 %

add 1 mL/ L water of Natural Rooting & Fruiting hormones. This hormone spray will bear the following benefits:

i Less internode distance in shoot growth.
ii Less disease.
iii Fewer physiological problems.
iv Fewer post harvest problems.
v Less alternate year bearing problems.

d). Use Zinc chelate (20 mL/ L water) for Citrus plants once or twice annually.

e). Foliar application of magnesium Oxide or Magnesium Nitrate is more effective than ground application. Use 5 gms./ L water.

f). Copper Sulfate at 3 gms./ L water is effective in case it is deficient.

8.8 Citrus Deficiency Symptoms:

8.8.1 Zinc: New leaves are small, in the shape of a spear, intervein chlorosis, short internodes. Reduced blooming, small fruit yielding little juice.

8.8.2 Manganese: New leaves of normal size bearing intervein chlorosis but more pale and less affected than by the lack of Zinc. Small fruit and reduced production.

8.8.3 Boron: Small malformed leaves having undulations at the petioles and veins projecting outwards. Deformed fruit of reduced size having a thick and irregular peel. Small, malformed dark seed.

8.8.4 Iron: New leaves bearing chlorosis of thin reticulum. The veins remain green but the limbs turn yellow.

8.8.5 Molybdenum: Old leaves bear yellowish spots, flowers and small fruit are shed.

8.8.6 Copper: Large new leaves on stems growing excessively as if there was an excess of N. In some varieties death of new stems may occur.

8.8.7 Nitrogen: Old leaves bearing a homogeneous yellowing, poor vegetation, small leaves, small fruit having thin peel.

8.8.8 Phosphorus: Old leaves having a copper tint, leaves and flower buds fall off, rough thick and spongy peel and fruit having hollow centers.

8.8.9 Potassium: Fruit are small and bear a smooth, thin peel. Leaves and fruit may fall off prematurely.

8.8.10 Magnesium: Old leaves bearing a yellowing from the tip to the leafstalk forming an inverted V.

8.8.11 Calcium: New leaves bearing yellowing from the borders to the center, death of new stems. Poor shoot and petiole developed implying low resistance. Leaves, flowers and fruit are shed at drought.

8.8.12 Sulfur: New small leaves bearing a homogeneous yellowing.

8.9 Strawberries are a fast growing fruit that are fetching handsome returns in the market. There is scope for fresh as well as processed strawberries grown in Abbottabad. A good fertilizer regime can ensure a rich harvest.

8.9.1	Ammonium Sulfate	1 bag.
8.9.2	TSP	2 bags.
8.9.3	SOP	2 bags.
8.9.4	N + inhibitor + Ca + Mg	25 L at transplanting followed by 3 applications at 21 day intervals through banding application.
8.9.5	Complete Micro Nutrient + Ca + B	5 mL Micro Nutrients + 5 mL Ca + B. 1 week after transplanting followed by 2 week intervals for a total 4 sprays.

8.10 Pakistan is growing large quantities of fruit and vegetables. With improvements in yield and quality we can very easily attain Net Exporter status. This is possible through Community growing and marketing for export. The process can be greatly aided by the establishment of dedicated Export Houses in the Private Sector. Food grade tin from Malaysia can be readily turned to canning by the use of Hand Lines that are exempt from taxes as they consume no electricity. These hand lines are relatively inexpensive and easy to install and operate. Some of the impeding factors are:

8.10.1 Lack of Proper transportation: Refrigerated trucks, containers or rail wagons are required for fresh fruit export.

8.10.2 Cold Storage is required for holding fruit whether as fresh export or in process of processing/ canning. Earth sheltered, Ceramic Adobe, Passive Solar construction can greatly allay this problem by bringing down construction and operating costs.

8.10.3 Facility & Services: Clearance, quarantine and commercial services are needed to back up the potential exporters.

8.10.4 Post harvest Losses have to be curtailed.

8.10.5 Growing for export means to grow with specific markets and their standards in mind.

9. Vegetables:

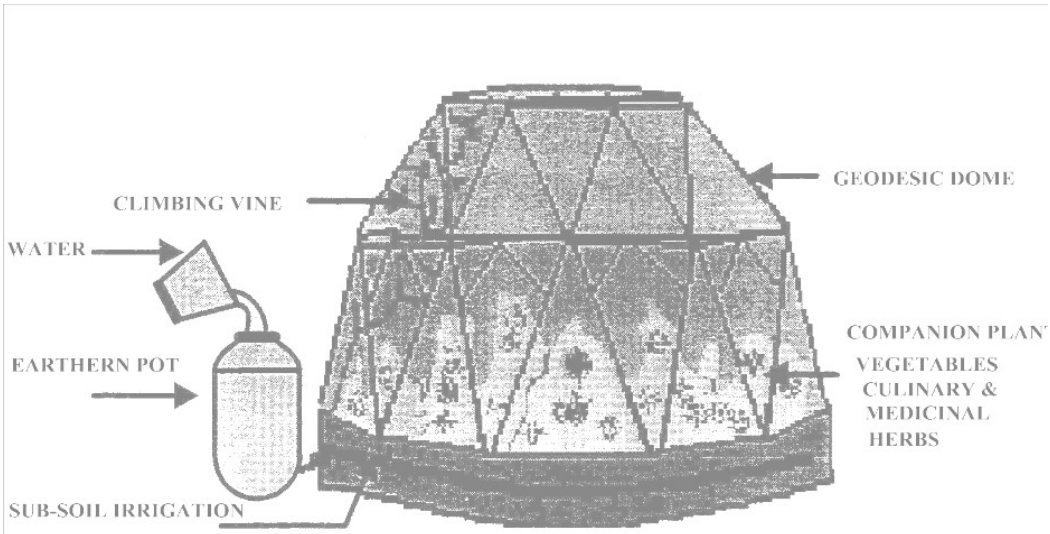
9.1 The foremost concern in vegetable farming is certified seed for suitable crops. Soil, moisture, climate and market conditions determine suitable crops. The first three can be manipulated in small but appropriate quantities. Market conditions and demand can be stimulated in large quantities and by appropriate varieties. Community based farming and growing for marketing and export is one such viable and profitable option. The growing of herbs and expensive out of season vegetables is relatively easier and less prone to pests than extensive

farming. The climate conditions all over the District are conducive to growing summer vegetables when the plains of Pakistan are too hot to sustain them. A Commercial Firm in Abbottabad is already making such an effort, both in the Rash plain as well as in Thandiani. One ton of Ice Berg Lettuce is exported on a weekly basis from mid summer to autumn. Particular care has to be taken to protect the crop from hailstones.

9.2 The Wah Garden, in its large size can readily supply 1 kg. per week. One thousand similar Herb & Vegetable gardens can supply the existing demand. A Cluster group of Community Based Organizations can readily meet the targets in both quality and quantity. Combined with herbs and other vegetables the said gardens can meet the income and nutrition requirements of an entire family each. Replacing expenditure requirements of Rs. 50.00 per day and providing an income of Rs. 200.00 a week is equivalent to Rs. 2,300.00 per month.

9.2.1 Soil consists of prepared compost from EM Composting. This takes care of the green and other decomposable matter and manure solid waste disposal problems of the family. The quick turn over period of 15 days in summer and 20 to 25 days in winter maintains interest and provides a constant source of Compost. Certified seed in Kitchen Garden packing is being arranged. In the mean time organized Communities can benefit from Large Commercial packings. Sub-soil irrigation from water harvesting supplied cisterns will cater to the moisture requirements. Liquid Major, Secondary and Micro Nutrients as well as Natural and Safe Hormones and Rhizobium bacteria are available to provide environmentally safe, stabilized and complete nutrition that would ensure Grade A, Export Quality produce. This is a major intervention that is waiting to happen and should be given the attention that is due. Environment protection with clear plastic of 110 gm. per sq. meter for heat retention/ hail protection, Stitched, used polypropylene bags for frost protection and green shade material/ climbing vines for heat protection provide the rest of the equation for successful gardening.

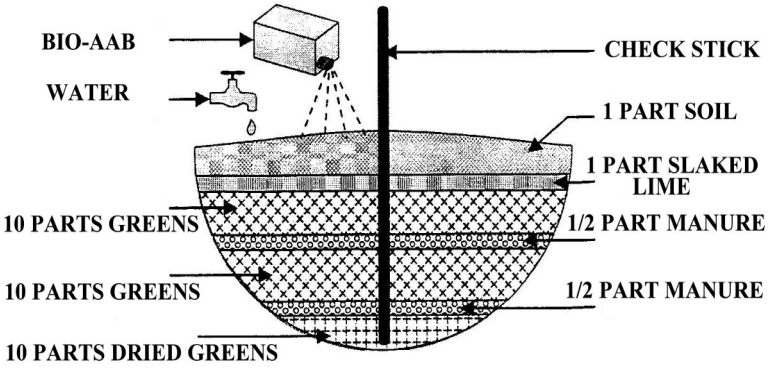
Figure 8: Environment Protected, Kitchen garden:



PERMACULTURE WITH SUB-SOIL IRRIGATION: THE WAH GARDEN.

9.2.2 The Garden is based upon the Australian concept of Permaculture. The use of exclusively organic fertilizer will render produce as eligible for export as Organic Farm Produce to meet a growing demand. The garden is simple to assemble and uses waste material as an effort towards keeping costs down as well as recycling other wise waste material. Pruned twigs from Eucalyptus or Wild Mulberry provide material for the Geodesic Dome. Used Fertilizer bags provide clear plastic of requisite weight and well as outer bags of polypropylene. The garden can be assembled as follows:

a). Compost Preparation:

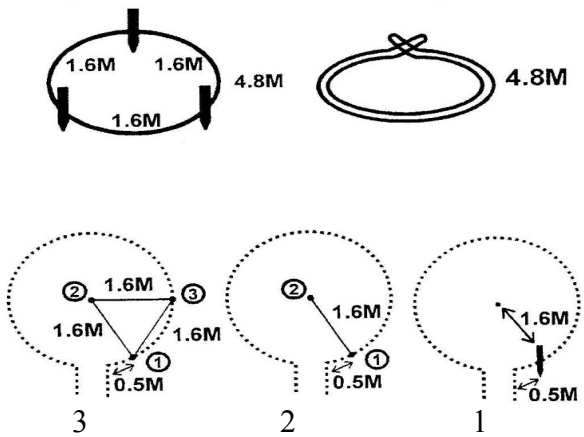


COMPOST

Figure 9: Compost.

A ratio of 1:30 manure and greens/ decomposable waste provides the requisite 1:20 Nitrogen: Carbon ratio. Water should be sufficient to make the mixture like a moist towel that does not drip, this can be attained by adding water to 50 % the mixtures volume. Bio-Aab or Effective Microbial Technology prepared mix is mixed in equivalent weight of sugar source and diluted with 100 times its weight of water. Quantity of Base Bio-Aab can be determined by dividing quantity of water to wet mixture of decomposable material by 100. Thus if water required is 500 L/ 100 = 5 Liters Bio-Aab Base.

b). Figure 10: Making the bed (Mandala or Circular):



The two ends of a piece of rope 4.8 m in length are tied together. Wooden or steel stakes about a foot long are attached to the rope at 1.6 m intervals. The entrance point of the Garden is

determined and the first stake (1) is driven 0.5 m away from this point. The second stake (2) is driven at its maximum point of slack, towards the center of the proposed bed. The third stake (3) is similarly driven into the ground along the periphery of the proposed bed to form a triangle.

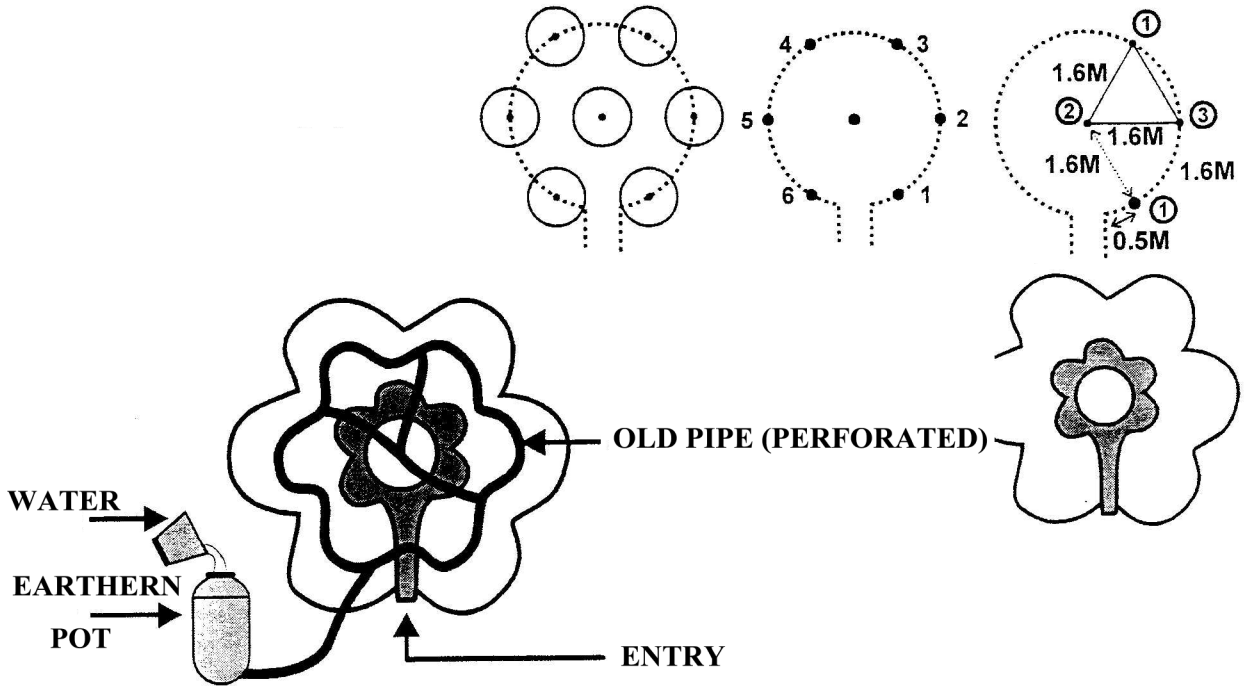


Figure 11: Mandala Bed:

Stake number 1 is then removed and a free stake is driven into its place. Stake number 1 is then driven into the proposed periphery at the maximum slack of the rope. The process is repeated until the circle is complete. Care is taken not to remove the center stake until the entire periphery is marked. The next step is to mark circles 1m in diameter around each marked point including the center. At this stage the Circular Garden bed is complete. In case a Mandala design is required the outer circles are joined in a wave pattern. The bed is then excavated to a depth of 4 to 6 inches, a second hand, 1 inch plastic garden pipe is repaired at required points and perforated at others to provide trickle release at 4 inch intervals. This pipe is laid to cover the entire bed. The bed is then filled with 50:50 mixture of compost and good garden soil. An earthen pot (Matka) is fixed close to the bed and the pipe is attached to a hole drilled into the base of the pot. Sub soil irrigation by osmotic pressure is now ensured as long as the pot is supplied with water. This can be straight from the roof of the family dwelling if water harvesting is being practiced.

c). The Geodesic Dome is required to provide protection to the bed. This protection is from the physical environment in the shape of the climate and also from household animals. Twigs can be harvested in winter to provide the basic material. The structure consists of 65 sticks. The size of the sticks is determined by a factor of 11.25: 13.5 multiplied by 4, 5, 6 or 7 representing small to larger sizes respectively. Sticks are cut in two sizes, 30 sticks are cut to 11.25 multiplied by factor desired while 35 sticks are cut to 13.5 multiplied by the same factor. For instance if the smallest size is desired then 11.24 multiplied by 4 = 45 inches (30 pieces) and 13.5 multiplied by 4 = 54 inches (35 pieces). The smaller size sticks are firmly secured as in (1) in six sets. Five larger size sticks per set are secured as shown in (2). These six sets are laid as in (3) and secured

firmly. This leaves 5 larger sticks to be secured at the periphery. Once the entire design is firmly secured it can be lifted from the middle to stand on its outer periphery as a solid base. In any case some of the ends will have to be secured by gradually lifting the structure in order for them to meet.

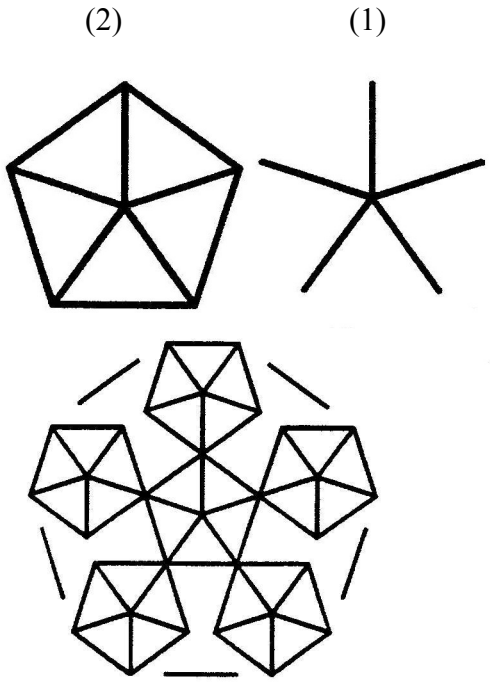
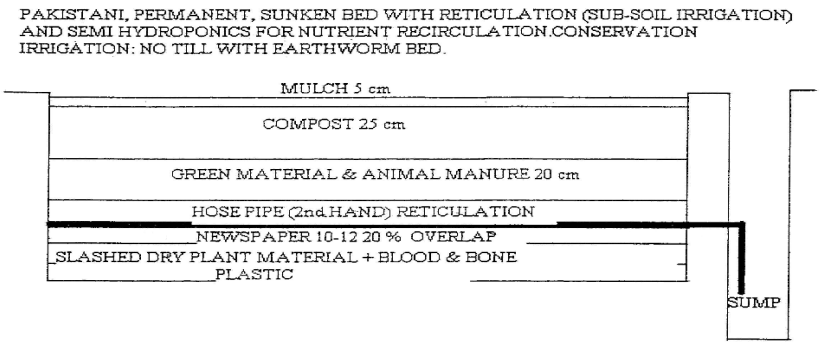


Figure 12: The Geodesic Dome.

This completes the Wah Garden. It can now be planted with Companion plants of high value to take maximum advantage of the market.

9.3 Both Australian and Chinese bed techniques have been tried out in Hazara Region.[1] However, a mixture of the two techniques (Raised Beds) is advocated with some variations. The resultant technique has been found to be best suited to the area.

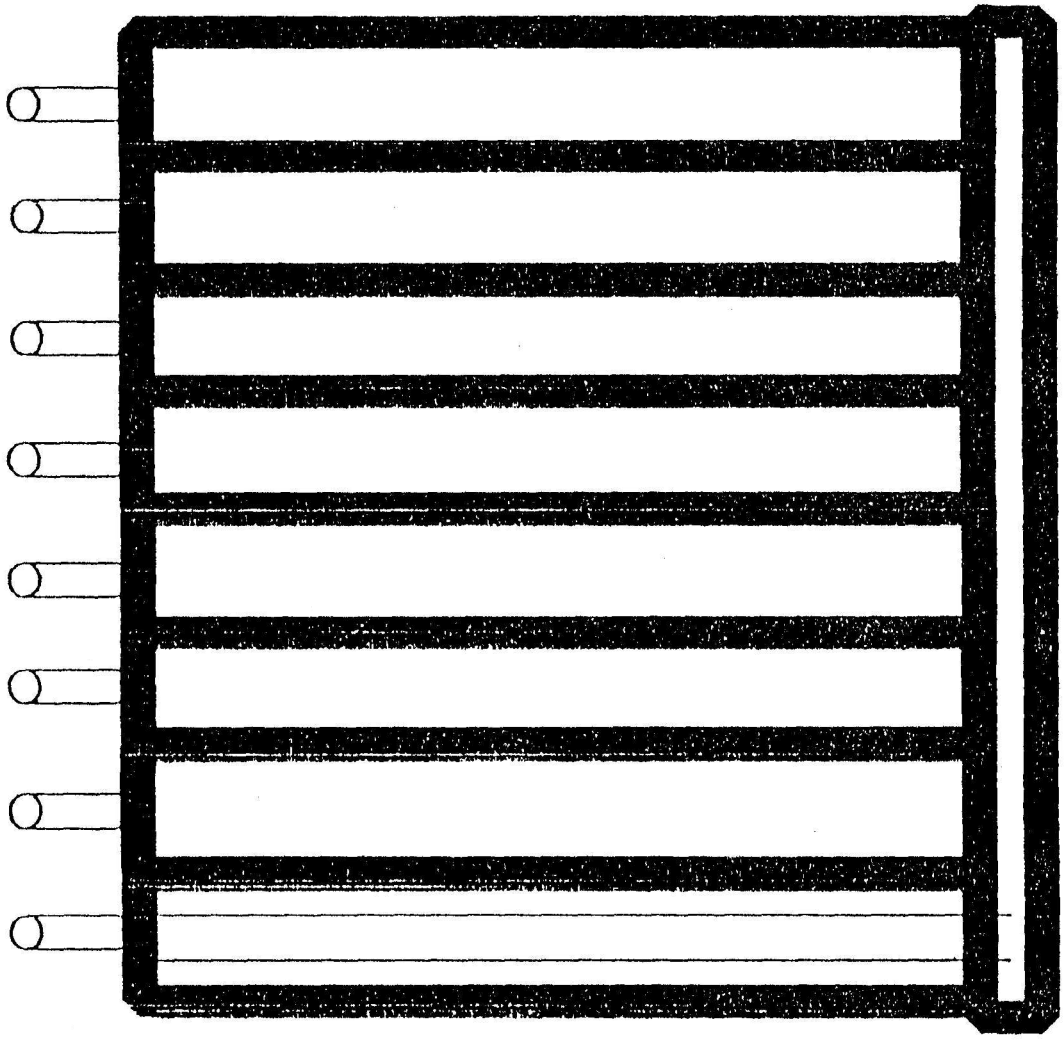
Figure 13: Pak Perma Bed.


PAKISTANI, PERMANENT, SUNKEN BED WITH RETICULATION (SUB-SOIL IRRIGATION)
AND SEMI HYDROPONICS FOR NUTRIENT RECIRCULATION.CONSERVATION
IRRIGATION: NO TILL WITH EARTHWORM BED.
MULCH 5 cm
COMPOST 25 cm
GREEN MATERIAL & ANIMAL MANURE 20 cm
HOSE PIPE (2nd HAND) RETICULATION
NEWSPAPER 10-12 20 % OVERLAP
SLASHED DRY PLANT MATERIAL + BLOOD & BONE
PLASTIC
SUMP

[1] By Khidmat Foundation.

These beds can be duplicated in an incremental manner depending upon land and resources available.

Figure 14: Pak Perma Beds Field.



The circles on the extreme left represent water inlets that can be independent or combined. Two second hand, perforated pipes run into each bed that is 4 ft. wide. There are walk ways between each bed and at the head and tail. An excess water drainage channel, which can be lined with plastic, is provided at the extreme right. Lengths of the beds are determined by land situation. The beds can be provided irrigation from Rain Guns that are available at Rs. 4,500.00 per unit of 2 inch supply, 150 feet diameter sprinkle pattern. On the other hand a 1 ¼ inch Rain Gun Moving Trolley of 100 feet diameter sprinkle and 200 feet linear travel can be installed at a cost of Rs. 15,000.00 for the trolley.

9.4 Nutrient deficiencies will produce poor results in so far as quality and quantity is concerned. Moreover, the plants will be susceptible to pests and diseases. Some of the deficiencies of tomatoes are listed for reference.

9.4.1 Zinc: Small, thin and yellowish new leaves. Poor flowering and production rate.

9.4.2 Manganese: Chlorosis followed by a necrosis of the border and tips of new leaves.

9.4.3 Boron: Death of the buds and terminal leaves. Brittle tissue, flower and fruit fall off. Fruit bearing brown spots near the blossom.

9.4.4 Iron: Intervein Chlorosis of new leaves. On more severe deficiencies, the leaves grow totally yellow in color.

9.4.5 Molybdenum: Older leaves bear Intervein Chlorosis. Flowers and little fruit fall off.

9.4.6 Copper: New leaves bear blades protruding out in relation to the veins. Borders of old leaflets curl upwards.

9.4.7 Nitrogen: Plants grow slowly. Lower leaves bear a little green to yellow coloration and then dry up and die.

9.4.8 Phosphorus: Older leaves bearing a purple coloration on their lower part. Stems are thin and poorly developed.

9.4.9 Potassium: Chlorosis on the tip and border of lower leaves, followed by death of the tissue.

9.4.10 Magnesium: Intervein Chlorosis of the older leaves.

9.4.11 Calcium: Flowers and little fruit fall off. Apical decay of fruit (Blossom End Rot).

9.4.12 Sulfur: New leaves bear a light green or yellow coloration depending upon the intensity of the symptom.

9.5 Nutritional Programs:

9.5.1 Tomatoes:[1]

a). Purpose:

i. To control growth.

ii. To increase resistance to bacterial and fungal disease.

iii. To increase resistance to root diseases.

iv. To increase yield by setting more fruit.

v. To produce higher quality, more uniform colored and better sized fruit.

b). General Nutrition:

i. 100 mL Complete Major, Secondary and Micro Nutrient foliar pre-mix per acre to transplanted plants. This treatment should produce a boxier plant with more lateral growth.

ii. Repeat when plants are 3 weeks old, this will result in greater fruit set, reduced blossom drop and sturdier plant stems so tomatoes will not separate causing premature ripening.

c). Foliar Treatment:

i. 10 mL/ L water, Complete Nutrient pre-mix (5-18-12) + 10 mL/ L water, Calcium and Boron + 1 mL/ L water Natural rooting and fruiting hormones. Use 150 L water per acre every 2 – 3 weeks.

ii. For disease and pest control use Hormones and Complete nutrient an b). sr. i. in every shot of c). sr. i.

Major NPK Nutrients are recommended in additional as 1 bag each.

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[1] Stoller Pakistan (Pvt) Ltd.

9.5.2 Potatoes:

a). Purpose:

i. To increase stem diameter.
ii. To enhance root growth.
iii. To increase resistance to bacterial and fungal diseases.
iv. To increase resistance to root diseases.
v. To produce higher specific gravity of tubers.
vi. To increase yield by setting and bulking more tubers.
vii. To reduce soft rot.
viii. To reduce internal browning and hollow heart.

b). Treatments.

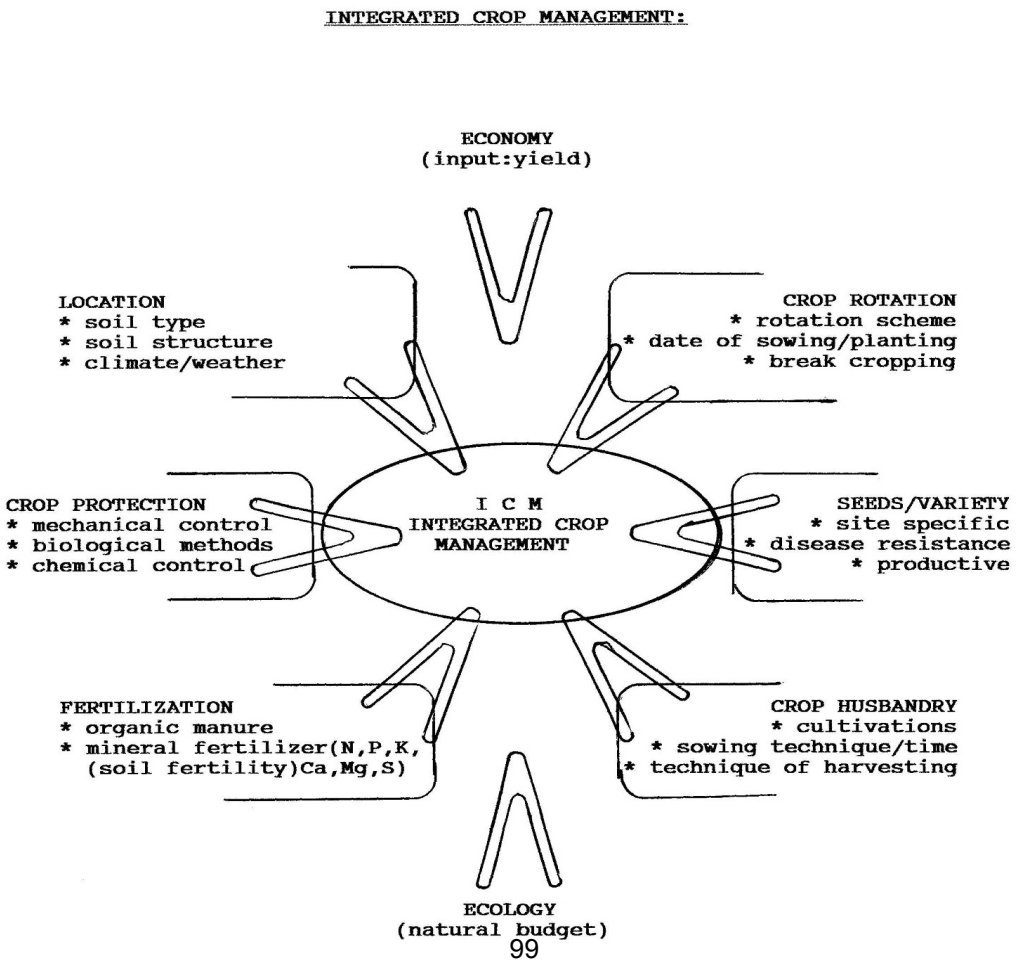
i Seed Treatment: Treat seed with 400 mL Natural rooting and fruiting hormones per ton of seed. Use 1200 to 1400 kgs. seed per acre.

ii General Nutrition: At planting use 3 bags of Ammonium Sulfate and 6 bags of NPK (30-30-30). Apply 50 L per acre of Amide Nitrogen (9-0-0-9 Ca) at planting by mixing into soil that covers seed. Band 50 L of Amide Nitrogen (18-0-0-9 Ca) at flowering, repeat after 15 days.

iii Foliar Treatment: ¼ L Hormones, 1 L Nitrate Balancer and 1 L Complete Major, Secondary and Miro Nutrient pre-mix per acre mixed in 150 L water every 10 to 14 days. Begin when plants have 4 leaves and stop 30 days before harvest.

9.6 Integrated Crop Management provides the best and safest results.

Figure 15: ICM.

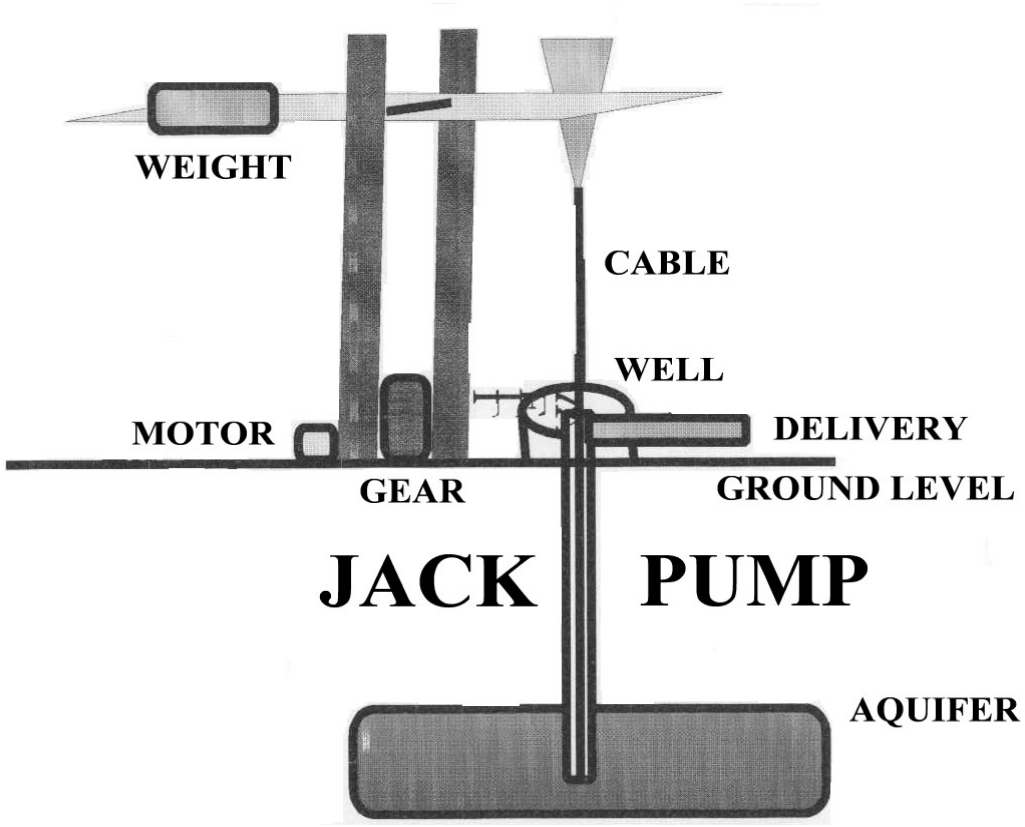


10: WATER EXTRACTION:

10.1 The methods presently used for extracting water from underground sources are wasteful on energy. The PHED and Agriculture Tubewells are forced to subsidize the cost of water. This is proving to be too burdensome for the exchequer.

10.2 The Jack Pump: Originally designed as Low Discharge Deep Well for extraction of oil. This principle has been adapted successfully for High Discharge, Deep and Shallow Well pumping for water. Moreover, energy required for pumping is so low that alternate means of energy like solar, wind or gas power can do the job. At present one such pump is operating in P.A.R.C., Water Resources Management Section. The jack pump is delivering ½ cusec water through a 14 inch pipe using a 1 HP motor. A Double arm system or increase in Stroke length up till 72 inches can provide 1 cusec while using a maximum of 2 HP.

Figure 16: The Jack Pump.



11. CONCLUSION:

The scope for vertical and horizontal improvement is tremendous. All that is required is to empower a Green Sector Development Authority, staffed with personnel equipped with the requisite skills. This concept has been put forward by Dr. Meera Khan and is examined in the Way Ahead! Horticultural Development at the grass roots level requires 3 to 5 years intensive efforts both in the field as well as in Capacity Development. Hands on Training will prove to be the most effective method of imparting skills. A strong and vibrant base of Cereal and Horticultural Production will definitely go a long way towards making the District sustainable.

CHAPTER 4: THE LANGUAGE OF THE PLANT:

"There is, apart from mere intellect, in the make-up of every superior human identity, a wondrous something that realizes without argument, frequently without what is called education (though I think it is the goal and apex of all education deserving the name), an intuition of the absolute balance, in time and space, of the whole of this multifariousness, this revel of fools, and incredible make-believe and general un-settled-ness, we call the world; a soul-sight of that divine clue and unseen thread which holds the whole congeries of things, all history and time, and all events, however trivial, however momentous, like a leashed dog in the hand of the hunter. (Of) such soul-sight and root-center for the mind, mere optimism explains only the surface". [1]

1. INTRODUCTION: The single most important and vital issue that faces our Nation today is the Production of Food. Hundreds of years of Agriculture have depleted most of our soils. The problem is further compounded by the fact that nutrient inputs are either unavailable, too expensive or chemically unstable and harmful. When we learn that the nutrients that we are using are not readily available to the plants; lack essential trace elements; are subject to hydrolysis, volatilization and leaching and are being used in an inefficient manner. We realize that we are effectively wasting our meager cash resources. We must understand that yields per acre are not increased by adding more and more chemical macro-nutrient fertilizers. It is important to realize that less is more when availability of nutrients is timed with actual requirements. We need to completely change our thinking and understanding of Crop Management. In the words of Jerry Stoller[2], "Take solutions to Farmers by understanding the language of the plant and treating their problems." This strategy effectively solves the problems of all farmers. However, our main concern is with the small landholders and contract farmers. Small land holdings; expensive inputs and diminishing returns have combined to break their backs. Resultant misery and malnutrition is all too well known and needs no elaboration. Agriculture contributes about **24** % of Pakistan's **GDP**, employs about **45** % of the labor force and earns roughly **60** % of the total value of exports. The population of the Country stands at about 140 million souls. Cultivated area is about 53.37 million acres. Thus per capita availability is 0.38 acres. About 22 million acres are termed as culturable waste. Yields per acre are abysmally low, when compared with other Countries.

2. DEFINITIONS:

It is important to clarify a few terms that will be used in this paper.

2.1 Essential Nutrient Elements: Plants need at least 17 essential, naturally occurring elements for growth (on-going research is uncovering additional elements). Three of these elements (carbon, hydrogen and oxygen) are obtained from the air and water. They comprise 90 % or more of the dry matter. The remaining 14 elements are obtained from the soil. They are:

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[1] Walt Whitman, Specimen Days and Collect, Philadelphia, 1882, p.174.

[2] The Sections on Macro, Secondary and Micro-Nutrients are entirely inspired by Stoller International and Stoller Pakistan Ltd. With due appreciation to Dr. Jerry Stoller and Dr. Zia Javed.

2.1.1 Macro-Nutrients:

a)	Nitrogen.	N
b)	Phosphorus.	P
c)	Potassium.	K

2.1.2 Secondary Nutrients:

a)	Calcium.	Ca
b)	Magnesium.	Mg
c)	Sulfur.	S

2.1.3 Micro-Nutrients:

a)	Manganese.	Mn
b)	Iron.	Fe
c)	Boron.	B
d)	Zinc.	Zn
e)	Copper.	Cu
f)	Molybdenum.	Mo
g)	Chlorine.	Cl
h)	Cobalt.	Co

2.2 Common Deficiency Symptoms:

2.2.1 Chlorosis: Lack of green color in leaves, caused by lack of chlorophyll. There are three types of chlorosis.

a) Interveinal: Here the veins remain green while the rest is chlorotic.

b) Intraveinal: Here the leaf's veins are chlorotic while the rest remains green.

c) Uniform: Here the entire leaf is chlorotic.

2.2.2 Necrosis: Tissue dies and usually assumes a brown color.

2.2.3 Stunting: This is caused by a slowdown in metabolism or cell division. It can also be caused by shortened internodes due to less cell elongation.

2.2.4 Distortion**:** Here the leaves become spongy, thickened or curled.

2.2.5 Soil Productivity: The capability of a soil to produce a specified plant (or sequence of plants) under a specified system of management. This is basically an economic term and not a soil property. The productivity of a soil is usually expressed in kilos per hectare when using a particular management system in which items such as planting date; fertilization; irrigation schedule; tillage and pest control are specified .

2.2.6 Soil Fertility: The quality of land that enables a soil to provide the proper compounds, in the proper amounts and in the proper balance, for the growth of specified plants when temperature and other factors are favorable.

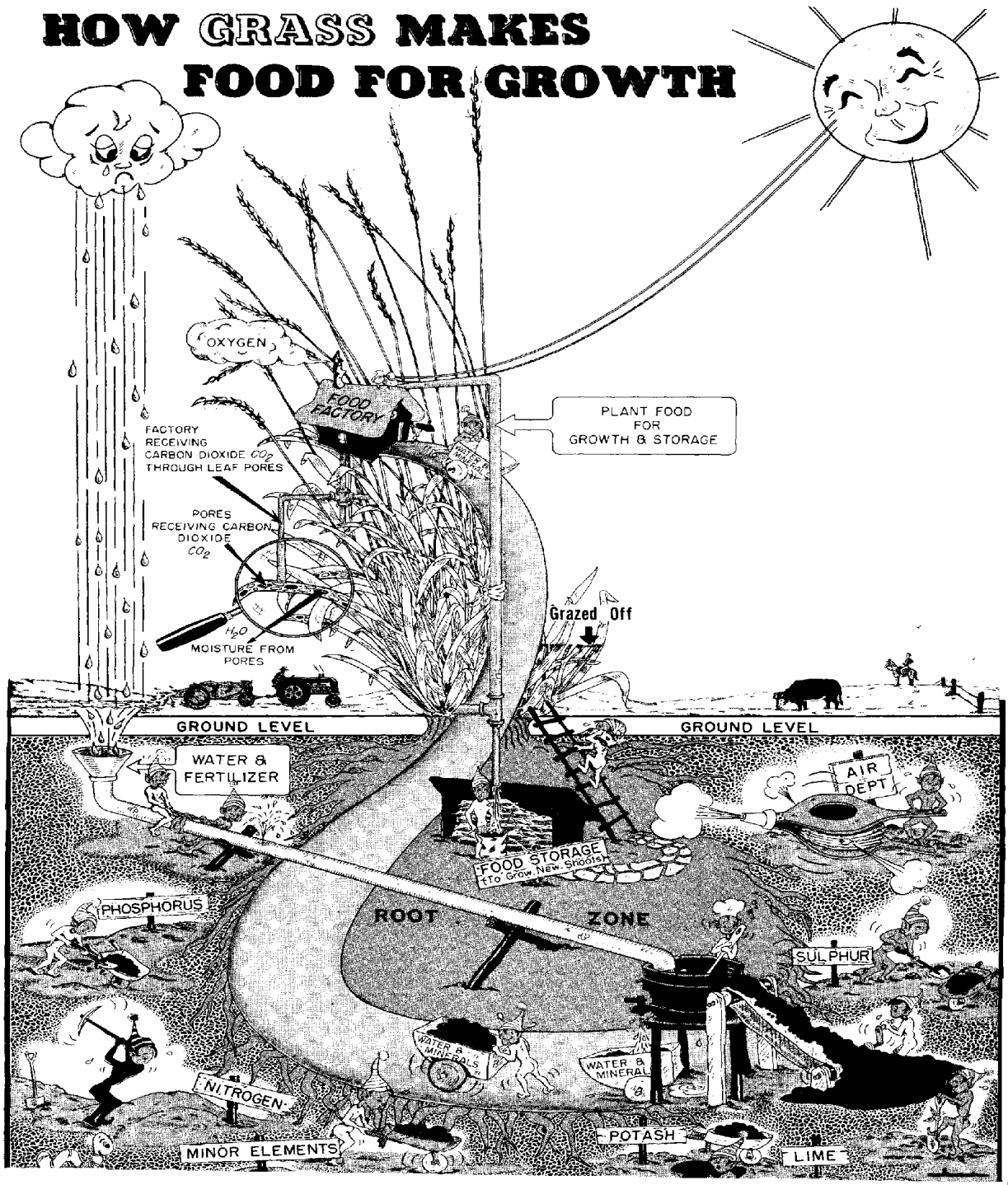

HOW GRASS MAKES FOOD FOR GROWTH
OXYGEN
FOOD FACTORY
PLANT FOOD FOR GROWTH & STORAGE
FACTORY RECEIVING CARBON DIOXIDE CO_2 THROUGH LEAF PORES
PORES RECEIVING CARBON DIOXIDE CO_2
H_2O MOISTURE FROM PORES
Grazed Off
GROUND LEVEL
GROUND LEVEL
WATER & FERTILIZER
AIR DEPT
FOOD STORAGE (To Grow New Shoots)
PHOSPHORUS
ROOT ZONE
SULPHUR
WATER & MINERALS
WATER & MINERALS
NITROGEN
MINOR ELEMENTS
POTASH
LIME

Figure 1: Plant Food Manufacture.

3. ROLE OF NUTRIENTS IN PLANTS:

3.1 Nitrogen:

3.1.1 Functions:

a) Component of all proteins.
b) Major constituent of chlorophyll.
c) Component of nucleotides, coenzymes, alkaloids and nucleic acids.

3.1.2 Deficiency Symptoms:

a) Uniform Chlorosis, appearing first on lower leaves, which may turn yellow or brown and die.
b) Growth is greatly reduced.

3.2 Phosphorus:

3.2.1 Functions:

a) Important in energy transfer as part of adenosine triphosphate.
b) Plays a major role in the storage of metabolic energy.
c) Constituent of many proteins, coenzymes, nucleic acids and metabolic substrates.
d) Involved in the synthesis and utilization of carbohydrates and proteins.

3.2.2 Deficiency Symptoms:

a) Purplish color due to the development of anthocyanins from an accumulation of sugars.
b) Purple veins.
c) Growth is greatly reduced.

3.3 Potassium:

3.3.1 Functions:

a) Functions in regulatory mechanisms: Photosynthesis, Carbohydrate Translocation and Protein Synthesis.
b) Functions as an enzyme co-factor.

3.3.2 Deficiency Symptoms:

a) Dying of tissue beginning at tip and margin of lower leaf and progresses throughout the entire leaf.

3.4 Calcium:

3.4.1 Functions:

a) Cell wall component and plays role in the structure and permeability of membranes.
b) Utilized for continuous cell division and formation.
c) Involved in Nitrogen metabolism.
d) Reduces plant respiration.
e) Aids translocation of photosynthates from leaves to fruiting organs.

f) Increases fruit set.
g) Controls water uptake by cell colloids.
h) Plays significant role in vegetative habits of the crop.
i) Abundance of Calcium results in production of smaller plants but stimulates early and abundant fruiting.
j) Acts as protective sieve for nutrients to seep through in passing into cells
k) Neutralizes Organic Acid by-products formed during plant growth by forming Calcium Oxalates.
l) Alters availability of some nutrients and prevents toxic effect of others.

3.4.2 Deficiency Symptoms:

a) Uniform chlorosis appearing first on young leaves.
b) Growing tips of roots and shoots may die.
c) Plants appear stunted.

3.4.3 Factors Contributing to Deficiency:

a) Low pH soils (acid) tie up Calcium.
b) High Nitrogen applications.
c) High Potassium levels.
d) Not mobile in the plant.
e) Calcium in plants seems to exist in sensitive balance with Magnesium, Potassium and Boron. Imbalance causes abnormal performance of plant function.
f) Leaches out of soil as Calcium Bicarbonate and becomes unavailable to the plant.

3.5 Magnesium:

3.5.1 Functions:

a) Key element of chlorophyll production
b) Activator and component of many plant enzymes.
c) Improves utilization and mobility of Phosphorus.
d) Very mobile in plants.
e) Vital role in photosynthesis.
f) Directly related to Grass Tetany When Mg is dissolved by the soil solutions, it is absorbed by the root system by diffusion or ionic exchange. The competition from Nitrogen, Calcium and particularly from potassium, interferes with the uptake of Nitrogen fertilizer and can cause an imbalance between Nitrogen, Calcium, Magnesium and other minerals. In cattle feeding on such forage, the problem is commonly referred to as nitrate poisoning or Grass Tetany. Where this is a problem it is imperative to maintain Magnesium levels, not as a cure but to reduce incidence).
g) Increases Iron utilization in plants.
h) Increases plant's ability to withstand unfavorable conditions and disease.
i) Influences earliness and uniformity of maturity.

j) Uptake and utilization usually occurs in the first 5 to 6 weeks after emergence. Row crops utilize Mg mostly in first 40 days. Small grain crops need most during early growth season. Tree crops need Mg when they make their first vegetative flush. Legumes generally contain more magnesium then phosphates. Sugar producing crops, like beets, corn, potatoes and fruit, require more magnesium than grain crops like wheat, rye and barley, which also benefit from this element.

3.5.2 Deficiency Symptoms:

a) Interveinal chlorosis on older leaves.
b) Chlorotic areas may die.

3.5.3 Factors Contributing to Deficiency:

a) Low levels of Magnesium in the soil.
b) High levels of Calcium (Calcium: Magnesium ratio), Sodium and/ or Potassium (interferes with Magnesium absorption at the root hair surface, should not be applied with Potash unless Potassium levels are extremely low).
c) Cool weather conditions restrict or inhibit uptake.
d) Rapid uptake of Nitrogen fertilizer (when greater than available Magnesium, causes deficiency and hinders Nitrogen Fixation by nodule Bacteria in legumes).
e) Low soil pH tends to accelerate depletion, since most Nitrogen fertilizers are acid forming, use of high rates will lower soil pH.
f) Magnesium leaches rapidly, thus more is lost due to soil mineralization than by crops utilization. In light sandy soils Magnesium deficiency is probably the greatest limiting factor for maximum yields.

3.6 Sulfur:

3.6.1 Functions:

a) Important constituent of plant proteins.
b) Important in enzyme reactions as a possible point of attachment of enzyme to substrate.

3.6.2 Deficiency Symptoms:

a) Uniform chlorosis of whole plant.
b) Thin stems, usually lateral meristems may be affected but not apical.

3.7 Boron:

3.7.1 Functions:

a) Important in sugar translocation.
b) Effects Nitrogen and Carbohydrate metabolism.
c) Protein synthesis.
d) Formation of plant hormones.
e) Promotes plant maturity by increasing cellular activity.
f) Increases set of flowers and fruit and yield and quality.

g) Water relations in the plant.

3.7.2 Deficiency Symptoms:

a) Chlorosis of younger leaves.
b) Internal browning of stems and fruit.
c) Shortening of upper internodes.
d) Growing points can become brittle.

3.7.3 Factors Contributing to Deficiency:

a) Immobile in the plant.
b) Soil pH 6.8 or higher (alkaline).
c) Leaching.
d) Heavily limed soils.
e) High Potassium levels.
f) High Nitrogen levels.
g) Low Phosphate levels.
h) Coarse textured, sandy soils.
i) Drought conditions.
j) When plant is expanding rapidly or flowering.
k) Low Organic matter in soils.

3.8 Iron:

3.8.1 Functions:

a) Chlorophyll synthesis. Not part of chlorophyll molecule but needed in the sequence of reactions which synthesize components of chlorophyll.
b) In enzymes for electron transfer, operates respiratory system of cells.
c) Compounds of Iron participate in reactions involving cell division and growth.

3.8.2 Deficiency Symptoms:

a) Interveinal chlorosis in younger leaves.
b) Larger veins remain green.

3.8.3 Factors Contributing to Deficiency:

a) Low supply of total Iron in soils.
b) Low supply of available Iron (Ferrous vs Ferric).
c) High soil pH, Calcareous soils (6.8 and above).
d) Land leveling and erosion.
e) High soil moisture levels and low soil temperature before and just after planting time.
f) Soil compaction.
g) High Phosphate applications form insoluble Iron Phosphates. Also tends to immobilize Iron in roots and leaves.
h) Competitive interaction with Zinc and Manganese.
i) Not readily trans-located from old to new leaves, thus a constantly available source is needed throughout the growing season.
j) Reactions involving cell division and growth.

3.9 Manganese:

3.9.1 Functions:

a) Controls several oxidation-reduction systems, formation of O2 in photosynthesis.
b) Predominant metal ion in metabolism of Organic Acids.
c) In higher plants, activates reduction of nitrite and hydroxyl amine to ammonia.
d) Part of important enzymes involved in respiration and protein synthesis.
e) Serves as activator for a variety of enzyme reactions such as oxidation/ reduction, hydrolysis and group transfer.
f) May have direct or indirect influence on chloroplasts and their conversion of sunlight to chemical energy.

3.9.2 Deficiency Symptoms:

a) Interveinal chlorosis of younger leaves.

3.9.3 Factors Contributing to Deficiency:

a) Soil pH above 6.5 (alkaline).
b) Low Organic matter.
c) Over liming on light sandy soils.
d) High Calcium and Magnesium interferes with the root system's ability to take up Manganese.
e) Low Sulfur levels make less Manganese available to the plant.

3.10 Copper:

3.10.1 Functions:

a) Catalyst for respiration.
b) Enzyme activator.
c) Major function in photosynthesis.
d) Major function in Reproductive Stage.
e) Indirect role in chlorophyll production.
f) Increases sugar content.
g) Intensifies color.
h) Improves flavor in fruits and vegetables.
i) Improves shelf life.
j) Co-factor for tyrosinase.

3.10.2 Deficiency Symptoms:

a) Pale yellow, bleached leaves.
b) Lack of firmness in leaves and stems.
c) Tips of stems may die.

3.10.3 Factors Contributing to Deficiency:

a) High Organic soils (fixes Copper).
b) Sandy soils (by leaching).
c) Soil pH above 7.0 (alkaline).
d) High Phosphates effect uptake of Copper.

e) High concentrations of Aluminum, Zinc, Iron and Manganese ions compete with Copper.
f) Does not move from older parts of the plant to younger leaves, therefore a continuous supply is required.
g) When released into a soil by natural weathering process, soil colloidal particles and micro-organisms along with the plant, compete for this element. Thus availability to the plant alone is restricted.
h) Soluble Copper reacts with Aluminum Silicates, Phosphates or other metal ions as the pH is reduced and becomes fixed in a form less available to the plant

3.11 Zinc:

3.11.1 Functions:

a) In enzyme systems that regulate various metabolic activities like protein synthesis, formation of chlorophyll, transformation of carbohydrates and regulation of the consumption of sugar in the plant.
b) Seed and Grain formation.
c) Maturation date.
d) Height of plant.
e) If present in sufficient quantities in the leaf, acts like anti-freeze in plants. Demonstrated in Citrus, Tomatoes and other crops.

3.11.2 Deficiency Symptoms:

a) Small chlorotic leaves which may have rough margins.
b) Internodes may be very short, giving the plant a rosette appearance.

3.11.3 Factors Contributing to Deficiency:

a) Total and available Zinc in the soil.
b) Soil pH, Calcareous soils (pH 6.0 and above).
c) High Phosphorous (Phosphate reaction).
d) Leaching and erosion.
e) Cold, wet springs.
f) Low organic matter or high muck (organic matter) in soil.
g) Land leveling, deep plowing, terraces (95% available Zinc in top 6" of soil).
h) Over liming.
i) High Nitrogen induces Zinc deficiency.
j) Soil compaction restricts root growth from where soluble salts like zinc sulfates are available.
k) Crop removal at harvest.

3.12 Molybdenum:

3.12.1 Functions:

a) In Nitrogenase, needed for Nitrogen fixation.
b) In high Nitrogen using plants, essential for nitrate reduction to protein through the amino acid state.

c) Essential for growth (Legume crops need great amounts, cauliflower, broccoli, lettuce and tomatoes have a relatively high requirement). Plants with low Molybdenum content may have high nitrate and low protein levels.

3.12.2 Deficiency Symptoms:

a) Uniform chlorosis of the whole plant.
b) Extreme curling of leaves may give whip-tail effect.

3.12.3 Factors Contributing to Deficiency:

a) Acid soils below 6.5
b) Crop rotation where liming interferes.
c) Iron and Aluminum tie-up Molybdenum.
d) Sandy soils more deficient.
e) Sulfate fertilization can increase deficiency.

3.13 Cobalt:

3.13.1 Functions:

a) Essential for symbiotic Nitrogen fixation.

3.14 Chlorine:

3.14.1 Functions:

a) Activates system for production of O2 in photosynthesis.

4. MAXIMUM YIELDS.

The requirements of various plants for nutrients are quantified. Von Liebig's law states **that the yield of a crop is limited by the element in least supply**. To illustrate this point, let us assume that there is enough of the following nutrients, in a one acre piece of land, to grow wheat as follows:

Table 1: Nutrient Effects Upon Yields.

Sr.	ELEMENT:	YIELD:
1	Nitrogen.	2 tons.
2	Phosphorus.	1.5 tons.
3	Potassium.	1 ton.
4	Zinc.	0.5 tons.

With good Agricultural practices and favorable weather conditions only 0.5 tons will be obtained and we will be effectively wasting NPK fertilizers. Thus we have raised our input price and lowered our yield expectancy. Without understanding this point, if we go on adding NPK fertilizers in the hope of increasing yields, we will be causing unbalanced growth leading to weakness and consequent lodging and susceptibility to diseases. A properly balanced fertilization program will save on inputs and yield better harvests. This proper balancing means providing those elements only when they are needed by the plant. In case elements are provided too

early they will become unavailable to the plant either due to leaching or conversion to immobile or non-soluble compounds. The period of critical need by plants for 12 soil, or foliar applied, nutrients are illustrated below, by division into three stages.

Table 2: Plants Critical Needs for Nutrients by Growth Period.

Sr.	0 -40 Days after Planting	Rapid Growth Period	Fruiting Period/ Reproductive Stage
1	Phosphorus	Nitrogen	Calcium
2	Zinc	Potassium	Boron
3	Iron	Sulfur	Cobalt
4	Manganese		
5	Copper		
6	Magnesium		

Elements under the first 40-day period, are not required in large quantities. However, they are not mobile, or in other words, they do not flow with the soil water. Root hairs need to come into direct contact with them for effective uptake. In case the root hairs are filled with mobile elements, such as those of the rapid growth period, they will be unable to make space for the nutrients that they actually require at that particular time. Moreover, since high levels of Potassium, Calcium and Sodium salts are quite mobile, this leads to more micro-nutrient deficiency in the first 40 days, when the ultimate character of the plant is being formed. Thus the closer these micro-nutrients are placed to the seed, the more likelihood of their being used effectively by the plant. This can be done by one of the following methods:

a) Coating the seed.
b) Banding non-mobile nutrients close to the seed.
c) Spraying them on the plant when it reaches 4 leaf stage.

This introduces three important concepts e.g. Seed Coating; Banding and Foliar Application. Broadcast Application of nutrients, as presently being practiced, is the least effective and most wasteful method of application.

4.1 Seed Coating: Seed can be coated with micro-nutrients; hormones; fungicides and pesticides. In Pakistan, we are using some pesticide coating. However, this only protects the seed during storage. If nutrient and hormone coated seed are introduced, we will have found an effective method of providing essential nutrients and compounds in the least expensive and least laborious manner, that requires the least technical knowledge on the part of the farmer. However, this is true only for the initial growth period. Secondly, not enough additives can be coated on the seed. Thus Banding and Foliar Spray are used to supplement nutrient availability. Seed coating can either be done by the farmer, just before planting, or by the Seed Company. The latter method requires Polymer coating to preserve the additives. Since Polymers

are obtained by using Urea as a raw material the method can easily be adopted in Pakistan.

4.2 Banding: Application of nutrients, for row cultivated crops, is a much more cost effective, as well as efficient method of providing nutrients. Broadcast application leads to uneven distribution and is more easily available to weeds where there are no crop seeds to compete with them. Secondly, more than twice the amount of fertilizer is required. This system lends even more credence to drill placement of seed combined with drill banding in a single operation. The actual practice is to place the nutrients 3 to 4 inches away from the seed in continuos flow form.

4.3 Foliar Application: Roots are fed from the leaves even though they are presently the major source of nutrient uptake. However, they merely take up the nutrients to transport them to the leaves where they are converted into food and redirected to the roots. Radio Chemical Analysis has amply proved that Foliar Application is much more efficient that soil uptake. In clay loams and organic soils it was 6 times more efficient. In sandy loams efficiency increased to 20 times. This is quite significant and needs to be adopted. Availability of low-cost backpack sprayers for pesticides makes this method practicable for small farmers.

5. THE LANGUAGE OF THE PLANT:

If we had the ability, as did many of our old farmers, to "listen" to what the plant was "saying" we would be able to cater to it's needs as and when required. In an uneducated and unsophisticated environment, it would prove to be too difficult to educate the Rural Masses regarding Plant Nutrition. However, our Culture will readily adopt Officially endorsed Crop and Soil Management Systems. Once the requisite knowledge or "Will" is either lacking or suppressed for whatever reasons, the effect is disastrous. We have reached a stage where faith in Official Policies are gauged as inconsistent with the welfare of the farmers. This needs to be overcome by effecting an immediate and positive change. It is quite obvious that if the plant and the planter are speaking different languages, there will be a failure in production. Thus we need to understand the language of the plant. Greater understanding of the plant's language will result in higher and sustainable yields that are consistent with sound environmental practices

5.1 Five Categories of Hormones:

5.1.1 Auxins: Mostly in the leaf tips and control the growing point to light. IAA is the major Auxin, it influences the rate of cell division and enlargement. Low rates increase while high rates retard. Roots are most sensitive at 0.02 ppb, buds follow in sensitivity at 0.1 ppm, while stems are least sensitive at 20.0 ppm. IAA regulates pholem transport as higher IAA attracts more pholem flow. Auxins move only in one direction, i.e. from the tips down and from the roots towards the tip. Auxin concentration is diluted when it moves from the growing point downwards.

5.1.2 Gibberellins: Gibberellins cause enlargement of cell walls, particularly internode cells and some fruit cells. They cause breaking of dormancy, move freely in the plant and are produced in the roots and new leaves.

5.1.3 Cytokinins: Cytokinins are produced in the root tips and are carried upwards in the xylem tissue. They loose concentration as they move towards the leaves. Cytokinins effect cell division.

5.1.4 Ethylene: Ethylene is stimulated by Auxins and can cause "Auxin like" effects. Ethylene stimulates flowering and abscission of flowers, fruit and leaves. This hormone is produced in fleshy fruit and increases ripening. Ethylene is a gas and causes senescence. It is called the aging hormone.

5.1.5 Abscisic Acid... ABA: This hormone is a growth inhibitor and promotes senescence, bud dormancy and seed dormancy. It is produced in the leaves.

Hormones are produced in some organs and move to other organs to change their characteristics. For instance, in wheat early growth is dominated by Gibberellins, the middle stage by Cytokinins and the later stages by Auxins. There is growing evidence that hormone regulation in plants is controlled by a central mechanism. This is distribution of Calcium in the protoplasm.

5.2 HORMONE INTERACTION:

5.2.1 Stem Elongation: Here Auxin + IAA is necessary, Gibberellins can interfere with this.

5.2.2 Apical Dominance: Whenever Auxins and IAA are produced in large quantities, stem growth is greater but bud growth is strongly inhibited. Further away from the growing tip the bud growth is weakly inhibited. When plants are pruned, new buds will form above the apex. Bud growth can be prevented by Ethylene, which is caused by too much Auxin causing Ethylene to be produced in cells. Cytokinins can release bud growth from the effects of Auxins + IAA.

5.2.3 Root Initiation: High Cytokinin/ Auxin rates develop shoot growth. It reduces the Auxin+ IAA effect. The above ratios inhibit shoot growth of roots towards the tip. When Cytokinins are lower back from the root tip, branch roots will grow. When Auxin rates get really high, adventitious roots will appear from the stem.

5.2.4 Senescence and Abscission: When flowers are fertilized they make Auxins which prevent abscission. Fruit abscission develops when Auxin is reduced in the flower. It may be that Auxins attack Cytokinins from the roots, which prevent abscission and senescence. Evidently ABA reduces Auxin in flowers or fruit. This would increase abscission.

5.2.5 Dormancy: Abscisic Acid (ABA) promotes dormancy in seeds and buds. Gibberellins and Ethylene break dormancy. It appears that IAA inhibits fruiting branches and bud break near the growing tip. Higher levels of Cytokinins apparently modify this. It appears that ABA effects bud break all over the plant and seems to be the main group of

hormones, along with Ethylene, that cause premature dying.

5.3 The hormone balance of the plant is responsible for dictating its response to environment factors. This is of prime importance and the major factor for maximum economic yield if response is adequate. Good nutrition is essential for the health of the plant but will fail to provide the desired results in case a plant is unable to use this nutrition. The size, shape and yield of a plant depend upon hormone balance. Fertilizer nutrients do affect this balance but the major factor is the climate. With changes in climate the hormone balance of the plant is altered. This is more in some varieties of plants and less in others. This is dictated by the genetics of that particular plant. It is possible to change the **Genetic Expression** of a plant so that it can quickly adjust to climate change. Thus it is not essential to change the basic Genetics of a plant, which, though desirable, is quite an expensive proposition. By modifying the genetic expression of a plant we can weather proof it and ensure that climate change has less impact upon yields. Since the last many years we, in Pakistan, are facing the problem of vagaries in weather that is causing a serious drop in yields. Thus, it is important to introduce this alteration of genetic expression.

5.3.1 Method: For example, if the soil remains dry after planting, the root will grow downwards. If the soil remains wet it will cause the roots to grow sideways. **The genetic expression of root growth is determined within the first 15 days after germination. It's genetic expression does not change thereafter.** Since we plant in wet conditions, we ensure sideways development of the root system. In case of root development in the upper area of the soil the plant will be less drought resistant and easily uprooted. Deep penetration will make the plant drought resistant and well anchored. It is possible to treat seed with hormones and make it "think" that it is growing in dry soil, no matter if the soil is actually wet. Our habit of introducing a plentiful supply of Nitrogen along with the seed, in the shape of Urea, is in fact harmful and wasteful. Nitrogen causes increase in root mass and does not change root direction. The same is true for growth enhancers and starter fertilizer.

5.3.2 Vegetative Growth Period: During this period a plant builds its root system. Calcium and Boron are the major nutrients that determine initial root length and lateral branching of major root hairs. These nutrients interact with hormones such as Cytokinins; Indobutyric Acid and small amounts of IAA. To some extent, Nitrogen has an effect upon these hormones. A plant's disease resistance is determined by the hormones being produced in it's root system. The roots, as we have seen, are primarily developed, mostly during the vegetative stage. Thus a plant's disease resistance is at its greatest during this stage. In case there is insufficient usable Calcium in the soil, the cell walls of the roots will be weak and result in leaking. Soil borne disease vectors will use this leaking as a "Chemical Taxi

(Chemitaxi)" to hitch a ride into the plant. Over abundant Nitrogen might also cause rapid root deterioration. Secondly, plants become top heavy as more Auxins and Gibberellic Acid is produced in the growing points above ground. This causes rapid upward growth at the expense of root growth. The farmer is pleased with the apparent health of the plant but is disappointed with the yield. Top heavy plants are also susceptible to lodging and frost damage. It is important that we bear two points in mind, one is that Nitrogen in sufficient quantities is essential to plant growth. Over abundance at a particular stage is however harmful. Secondly, there must exist an adequate supply of available Calcium and Boron in the soil. Insoluble Calcium is of no use to the plant. Pakistan's Calcareous soils are not evidence of sufficient Calcium as commonly believed. This is due to the fact that the Calcium is inert and insoluble. Dilute Sulphuric, Hydrochloric or Phosphoric Acid can be used to solubilize the Calcium in the soil. However, this is a temporary fix as the Calcium is later converted to Calcium Sulfate. Calcium Carbonate is of no use to the plant. Calcium Sulfate is 200 times more soluble. However, Calcium Chloride and Calcium Nitrate are 2000 times more soluble. Calcium Chloride is readily available in the market and is required in lesser quantities then Gypsum. Moreover, the double positive charge on the Calcium Ion repels the single charged Sodium Ion. Thus Sodium is not allowed to clog the root system and/ or burn delicate vegetable plants. Thus Calcium in available form is introduced as well as removes the problem of Sodium. Over and above this, Calcium Chloride also stabilizes Urea and keeps it in the Ammonium form. This material is a by-product of the Marble industry and has been used [1]with amazing results, in 1998, at Daharki, District Ghothki, Sindh. Five acres of summer vegetables and one acre of experimental wheat were treated. These acres were subject to salinity to varying degrees. Vegetable germination was 98% and came to term. Wheat saw an increase yield/ acre of 800 Kg. However, wheat was also treated with hormones and given split foliar applications of Urea stabilized with Calcium Chloride.

5.3.3 Reproductive Stage: This stage of growth triggers the most serious problems for the plant. The Carbohydrate flow is diverted from the roots towards growing points and reproductive tissue such as seed, storage tissue and fruit. Thus root growth decreases and less nutrients are absorbed and fewer hormones are produced. Other hormones are now effectively in control of the plant such as Ethylene and Putrescine. These cause the following problems:

a) More disease problems.
b) More physiological problems.
c) More stress problems.

[1] By the Khidmat Foundation

d) More aborting of flowers and fruit.
e) Premature ripening.
f) Early death of plants.

These all effect the hormone balance and cause early death of the plant which in turn effects yields. When yields are high the observation is that stalks and/ or stems are still green. This shows that the plant was still alive. If we can slow down the shift in Carbohydrate flow from the roots to the reproductive tissue, we can elongate the life of the plant. This will allow greater time for the grain to fill, or fruit to develop, as the case may be. Thus, the lessons learnt so far are that in the Vegetative stage we should help the roots to grow vigorously and in the Reproductive stage we must elongate the roots life. This is done by hormones. Every day that a plant's life is extended results in 4 % additional yield.

5.3.4 Movement of Carbohydrates: Carbohydrates and Proteins are produced in the leaves of the plant and then transferred to stalks, stems or branches. From here they are used by the vegetative growing points, such as roots and shoots. In order to replenish the Carbohydrate supply the leaf must have adequate Potassium, Magnesium and ABA (hormone). If too much IAA (hormone) and Nitrates are present this may not be possible. Research has revealed that nutrients and hormones can be manipulated in order to induce movement of Carbohydrates out of the leaves. The only way to reduce early dying is to ensure that stalks, stems and branches are full of Carbohydrates when the reproductive stage begins. This is hormone controlled.

5.4 Negative Growth Factors (NGF): Five major factors cause negative growth in plants:

5.4.1 Allelopathy: When seeds are planted in close proximity, the roots of one plant cause accumulation of toxins in the neighboring plant. This results in reduction of fruitfulness of each plant. Immunity to this toxin can be induced, this results in shorter plants, stems or stalks with larger diameters; more lateral branching, or suckers, or tillers; more fruiting points and more fruit; much longer root systems and no tap root. These results were practically observed [1]in wheat crop of the year 2000, in Mung village of Khanpur Tehsil, District Haripur, Hazara of N.W.F.P.

5.4.2 Soil Borne Diseases: Where root growth is slower, soil borne diseases are more severe. Low levels of Calcium, as earlier pointed out, cause this and result in Chemitaxi route into the plant for these diseases. Thus there is a requirement of avoiding this and also healing the plant if it is effected.

5.4.3 Foliar Diseases: These are more severe during the reproductive stage. This is caused by Ethylene and Putrescine accumulation in the plant.

[1] By the Khidmat Foundation

The plant can fight these with hormones produced in the roots and Calcium stored in the Cytosol.

5.4.4 Nematodes: Nematodes attack plant roots and introduce toxins into the plant. These can be controlled by hormones.

5.4.5 Stress: Hot and dry climate conditions cause stress in the plant. This causes:

a) Disease.
b) Early dying.
c) Premature ripening.
d) Abortion of fruit or seed.
e) Poor storage or shelf life.

5.5 Hormone Control: All of the above negative growth factors are hormone related and are not related to nutrients. Nutrients can effect the hormones, e.g. Calcium has a positive effect and Nitrogen has a negative effect. Hormones can speed up a plant's metabolism and result in more efficient use of chemical fertilizers. Thus with the addition of hormones, less fertilizers need to be used. Secondly, with a more complete "Diet" in so far as nutrients are concerned, we can achieve much better results. Hormone treatment of seed and plants, therefore is perhaps even more important than hybrid seed development. The full genetic potential of existing seed is achieved and yields are vastly improved. It is important to note that the cutting down of Macro Nutrients, as presently being used, will result in savings that offset the expense incurred in Hormone Treatment and Micro-Nutrient Supply. Secondly, improved yields will more than compensate for the money and efforts expended. Thirdly, Micro-Nutrients and Hormones are naturally occurring elements and compounds. Thus, the use of these elements and compounds are environmentally safe and highly desirable. It is important to note that hormone use in plants is nowise similar to indiscriminate hormones use in Poultry Production. The hormones suggested for use with plants are only those that would be normally produced by the plant itself if it were healthy or were to receive a balanced "Diet". These hormone Products should be registered with the EPA and must be natural.

6 PEST CONTROL WITH NUTRIENTS:

6.1 Sucking Insects: Aphids; Mites; White Fly; Thrips; Others:

Sucking insects feed upon amines and amino acids in order to form their own proteins. Plant proteins are of no use to these insects. Since the insects life cycle is short it needs massive quantities of proteins in order to lay eggs. Sucking insects usually attack and feed upon new leaves. New leaves have only pholem and no xylem tissue. As such, organic compounds are not being manufactured in the new leaves, they rely upon the compounds made in old leaves. Plant sugar can give these insects diarrhea, causing sticky plants.

Amines and amino acids move freely in pholem tissue. They are low on Calcium, Boron and other nutrients as they are not mobile or only slowly mobile in new tissue. When sucking insects destroy new leaves or vector in a virus the hormone balance of the plant is disrupted. This causes a major change in the older leaves. Proteins hydrolyze to amines and amino acids and become available to the sucking insects as food. Nitrogen also causes higher amines and amino acid levels in the plant. The more the nitrogen used the greater the threat. Zinc will lower the level of amines and amino acids in the new leaves. Thus, during critical periods, a foliar application of Zinc will treat the leaves. Repeat applications are required every 14 days.

7. THE LANGUAGE OF THE SOIL:

As with the plant, the soil too has a particular expression of its own. The condition of the soil will determine the plant's ability to uptake nutrients in order to go about its business of growth and reproduction. Limiting factors can only be overcome if they are understood and steps are taken to preclude their inhibiting characteristics. Soil content, condition and pH determine the plant's ability to uptake nutrition. Sophisticated soil, leaf tissue and sap analysis will provide exact data on available nutrients in the soil at the time that the sample was taken. However, delays in providing results will result in changes that might have occurred since that time. Secondly, these tests need to be carried out with every crop, as each preceding crop will have removed so much nutrition. The expenses involved are too high to be used to optimum advantage. This is particularly true for small and subsistence farmers. The parent material, out of which the soil is derived, indicates the presence or chronic absence of nutrients. For example, alkaline soils with pH of 8.0 and above are deficient in Iron. Excessive watering, needed to leach Sodium salts, results in further depletion. Incorrect Agricultural practices can also result in depletion of nutrients. For example Copper availability in poorly aerated and drained soils is very low. The interaction of various nutrients also determine their availability. For example, high levels of available Phosphate in soils can decrease Zinc uptake by plants. This results from heavy use of Phosphate Fertilizers in crops. The interaction between nutrients can either be antagonistic or stimulating. Mulder's chart is a graphic illustration of this complexity. Soil pH is a major factor which determines micro-nutrient availability and utilization. For example, the previously mentioned Zinc deficiency, due to excessive Phosphate, is increased when air and root temperatures are low. Light intensity is also an effecting factor. For instance, high light intensity and long days lower a plant's requirement for Manganese. In short, the complex Soil-Plant-Fertilizer interaction needs to be understood. When corrective measures are planned, many factors need to be considered and some attempts have to be given the status of trial and error. The Rizosphere (portion of soil close to surface and plant roots) is the area from which nutrition is absorbed. It is this zone that is corrected. For example, if an acidic fertilizer such as Ammonium

Sulfate is banded close to the plant's root zone, a local acidic zone is temporarily produced. This in turn increases Zinc, Manganese and Copper availability even though the soil pH of the rest of the field remains the same. Chelated or chemically combined, positively charged Cations (Zinc; Manganese; Iron; Copper; Magnesium or Calcium) with an organic, negative charged Chelating agent. The organic molecule surrounds the positively charged metal and protects the new chelated form of Cation from being chemically tied up in the soil. However, this needs to be considered. For example, the high Iron content of organic soils will cause replacement of Manganese chelate by Iron. This will result in a build up of Iron chelate and can increase the Manganese deficiency. This is because the replaced Manganese is rapidly tied up in the soil and becomes unavailable to the plant. Method of application is also important. For instance, Copper fertilizers applied directly to organic soils will result in copper combining quickly with the soil. Here foliar application is the preferred method for best results. Foliar application of fertilizers result in rapid response. However, the effects can be short lived and multiple applications are needed. Thus planning of nutrition is most important as correction of a deficiency or toxicity, when observed, results in damage already done and yield loss sustained. It is far better to understand how and when, which deficiency or toxicity can occur, and thus remove it before it effects yields.

8. CHEMICAL REACTIONS & INTER-RELATIONSHIPS.

8.1 What Happens to Nitrogen, in the Soil and in the Plant?

8.1.1 In the Soil.

Nitrogen is commonly applied to the soil as organic material; urea; ammonium and nitrate. Research shows that most nitrogen uptake by plants is in the ammonium and nitrate forms. Each of these forms of N has distinct advantages and disadvantages. There is little work on the uptake of urea and organic forms of N due to rapid conversion from assimilable forms of organic N to the more common forms of N available to the plant; ammonium and nitrate.

Organic Material and Urea: --- microbes and urease enzyme -→ Ammonium (NH_4^+) --- ammonium

(limited crop uptake NH_2) (plant uptake,

volatilization,

held by soil CEC)

and nitrite oxidizers -→ Nitrate (NO_3^-)

(plant uptake, leaching).

8.1.2 In the Plant:

Think of the plants metabolism of Nitrogen as an assembly line where components are put together for the end products, which are

proteins. It is possible to start building components on the assembly line from piece parts or from pre-assembled components. Nitrogen in its various forms makes up the bulk of the pieces and components. Nitrate Nitrogen is the most labor intensive input in that it begins at the very start of the production line.

Nitrate (NO3) ---nitrate and nitrite reductase -→ Ammonium (NH4) --- enzymes -→ Amides/ureides/amines ---biosynthesis -→ Protein.

Table 3: Nitrate (NO3-):

Sr	Advantages:	Disadvantges:
1	Easy to take up	Creates high vegetative/ weak growth.
2	Not toxic.	Increases disease susceptibility
3	Increases cation uptake.	Cation sink in fully expanded leaves.
4		Less stress resistance.
5		Auxin hormone dominance.
6		High energy requirements.

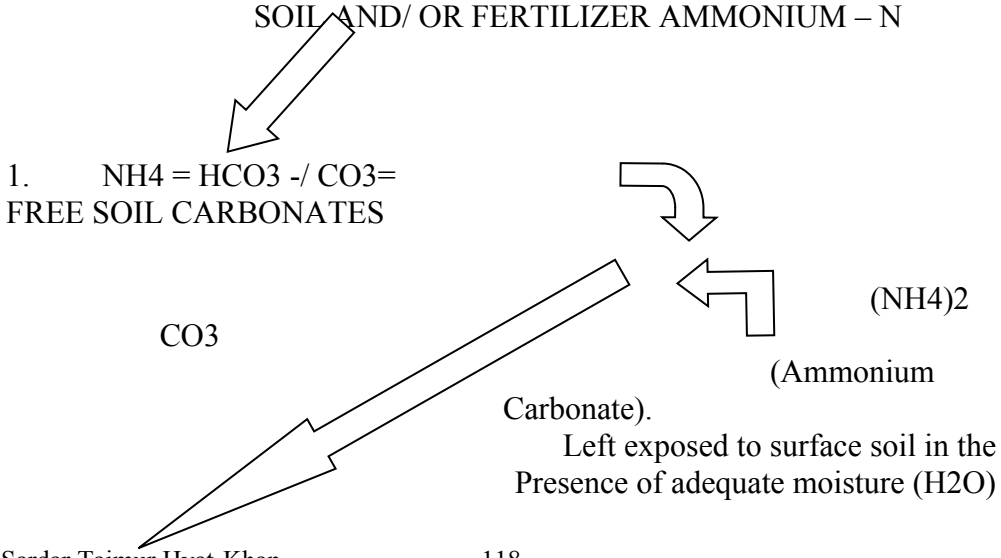
Table 4: Ammonium (NH4+):

Sr	Advantages:	Disadvantges:
	Encourages branching and reproduction.	Can become toxic in excessive quantities
	Does not create cation sink in leaves.	Reduces Cation uptake.
	More efficient form of N.	

Table 5: Amides/ Ureides/ Amines:

Sr	Advantages:	Disadvantges:
1	Amine N more efficient than ammonium	Normally only made by plants.
2	Greater root growth.	
3	Increases Cytokinin hormones.	
4	Helps plant resist stress.	

Figure 2: Ammonia – Volatilization Loss Pathway:



atmospher → Free Ammonia lost to the

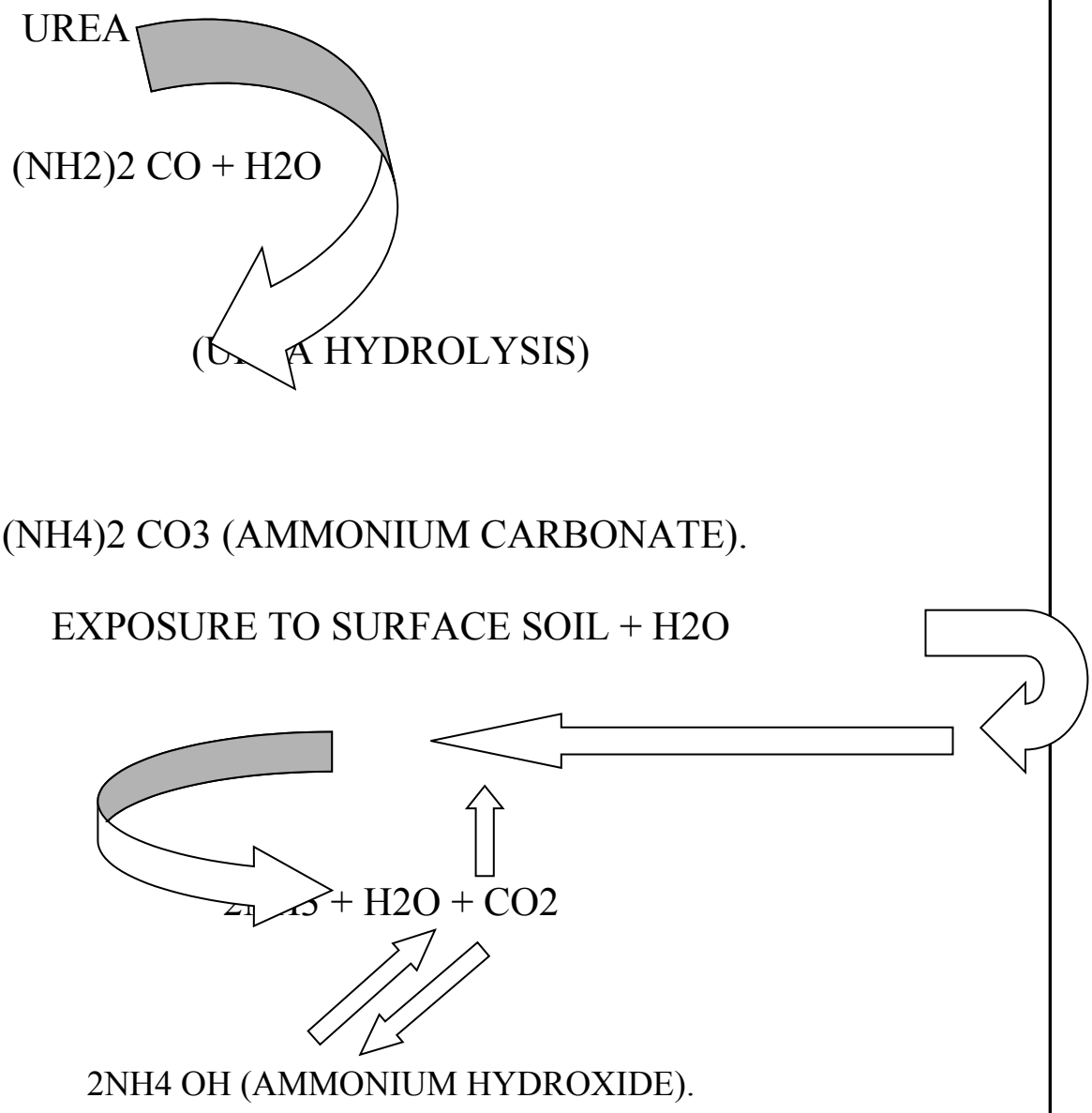
2. (2NH3 +) + H20 + CO2

⇧⇩

2NH4OH (Ammonium Hydroxide).

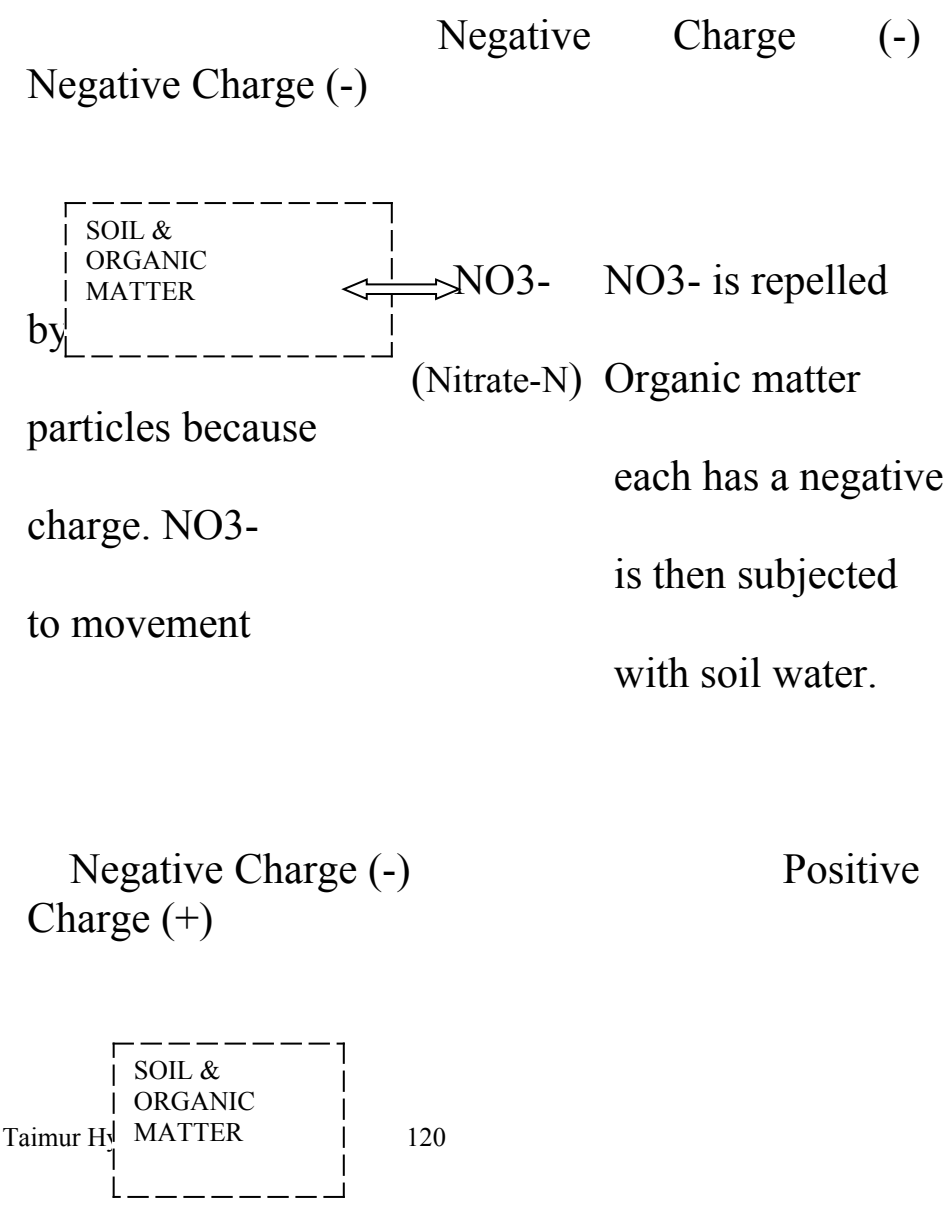
(UNSTABLE: REVERTS BACK TO FREE AMMONIA).

Figure 3: Urea Hydrolysis & Ammonia Volatilization:



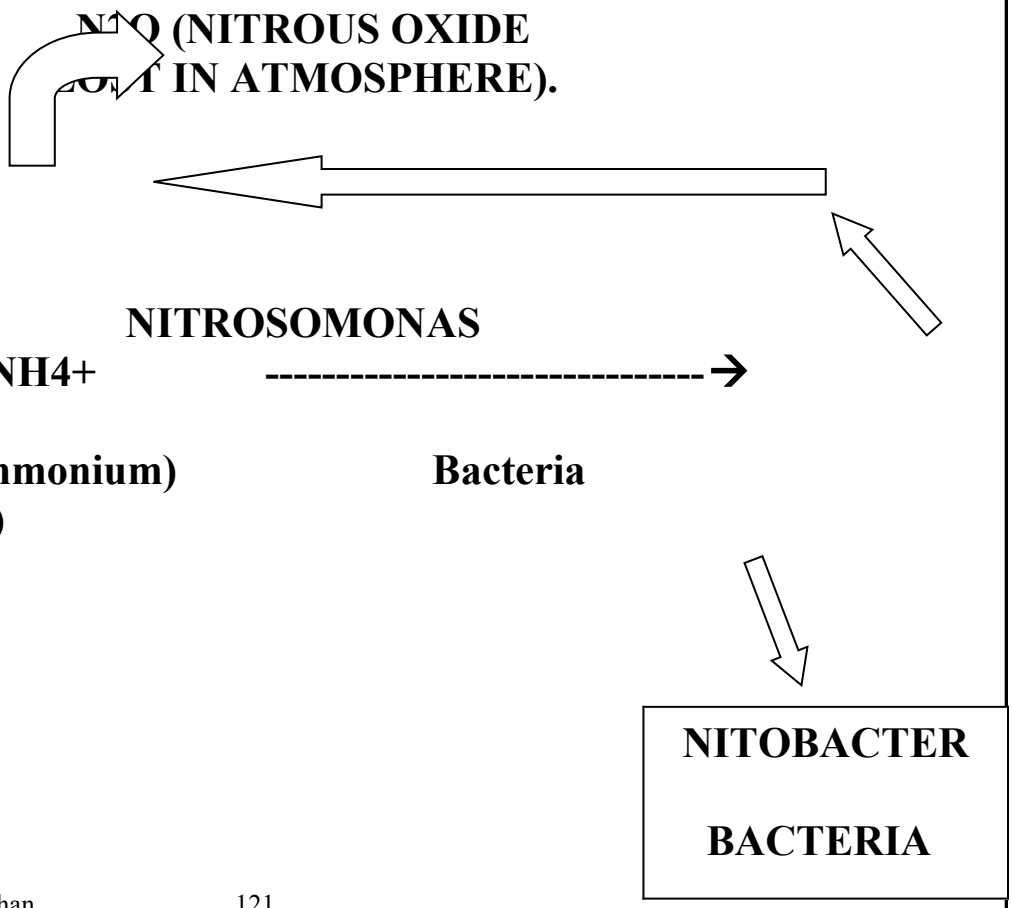
(UNSTABLE: REVERTS BACK TO FREE AMMONIA).

Figure 4: Nitrogen Retention by Soil & Organic Matter:


Negative Charge (-)
Negative Charge (-)
SOIL & ORGANIC MATTER
NO3-
(Nitrate-N)
NO3- is repelled by Organic matter particles because each has a negative charge. NO3- is then subjected to movement with soil water.
Negative Charge (-)
Positive Charge (+)
SOIL & ORGANIC MATTER

⟺ NH4 + NH4+ is attracted to soil particles (Ammonium–N) and Organic matter because of Opposite Charge attraction.

Figure 5: Nitrification Process:



NO3-

(Nitrate)

1. $CO(NH_2)_2 + H_2O$ — Urease Producing Bacteria → $2NH_3 + CO_2$

Urea Water → Ammonia Carbon Dioxide

2. $2NH_3 + 3O_2$ — Nitrosomanas → $2NO_2^- + 2H^+ + H_2O$

Ammonia Oxygen → Nitrite Ions Hydrogen Ions Water

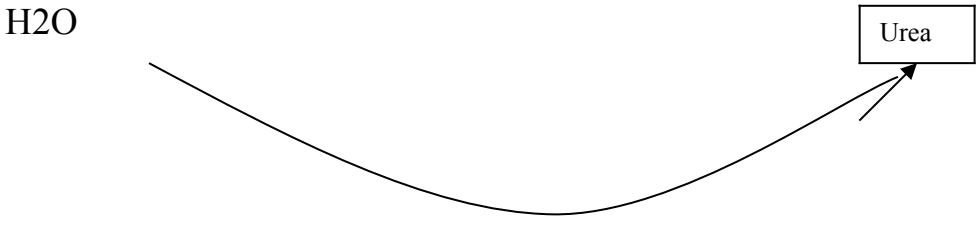
3. $2NO_2^- + O_2$ — Nitrobacter → $2NO_3^-$

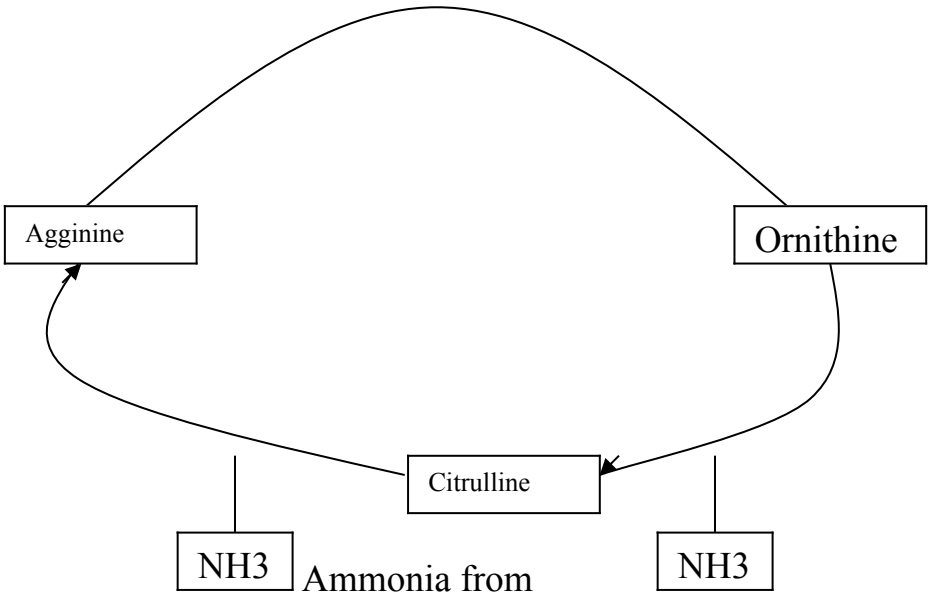
Nitrite Ions Oxygen → Nitrate Ions

$CO_2 + 2NH_3 \rightarrow C{=}O + H_2O$ (N, H_2 / N, H_2)

Figure 6: Biosynthesis

Urea produced as Urea OR ornithine cycle
Removal of Amino Group (-NH2) to form Ammonia (NH3)





Ammonia from Deamination of Amino Acids

FREE AMMONIA

UREA
$(NH_2)_2Co + H_2O$

$2NH_3 + H_2O + IO_2$

$2NH_4OH$

UREA HYDROLYSIS (WITHOUT THE PRESENCE OF CHLORIDE FERTILIZER AND UNINCORPORATED

AMMONIUM CARBONATE

(IN THE PRESENCE OF CHLORIDE FERTILIZER WITH OR WITHOUT INCORPORATION

$NH_4CO_3 + H_2O$

(UNSTABLE)

AMMONIUM CHLORIDE

$2NH_4Cl + H_2O + MG$

OR CO_3

Ca

{(KCl, Mg, Cl_2, $CaCl_2$) + H_2O} (FREE CHLORIDE)

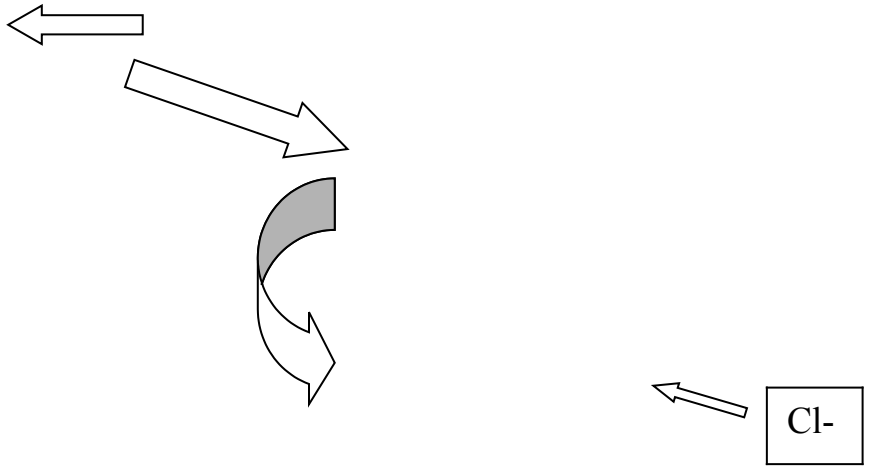
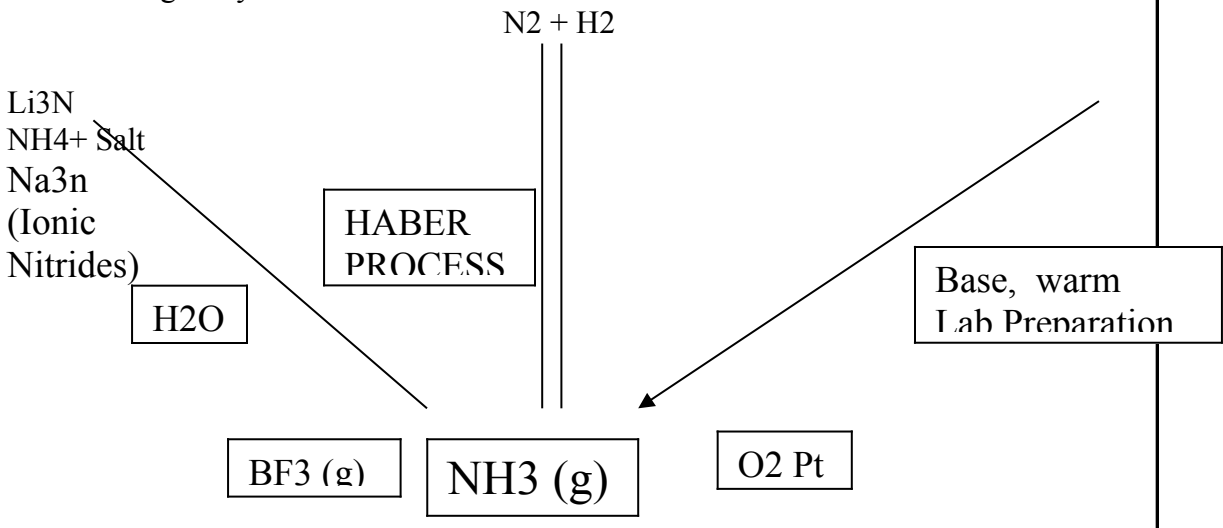
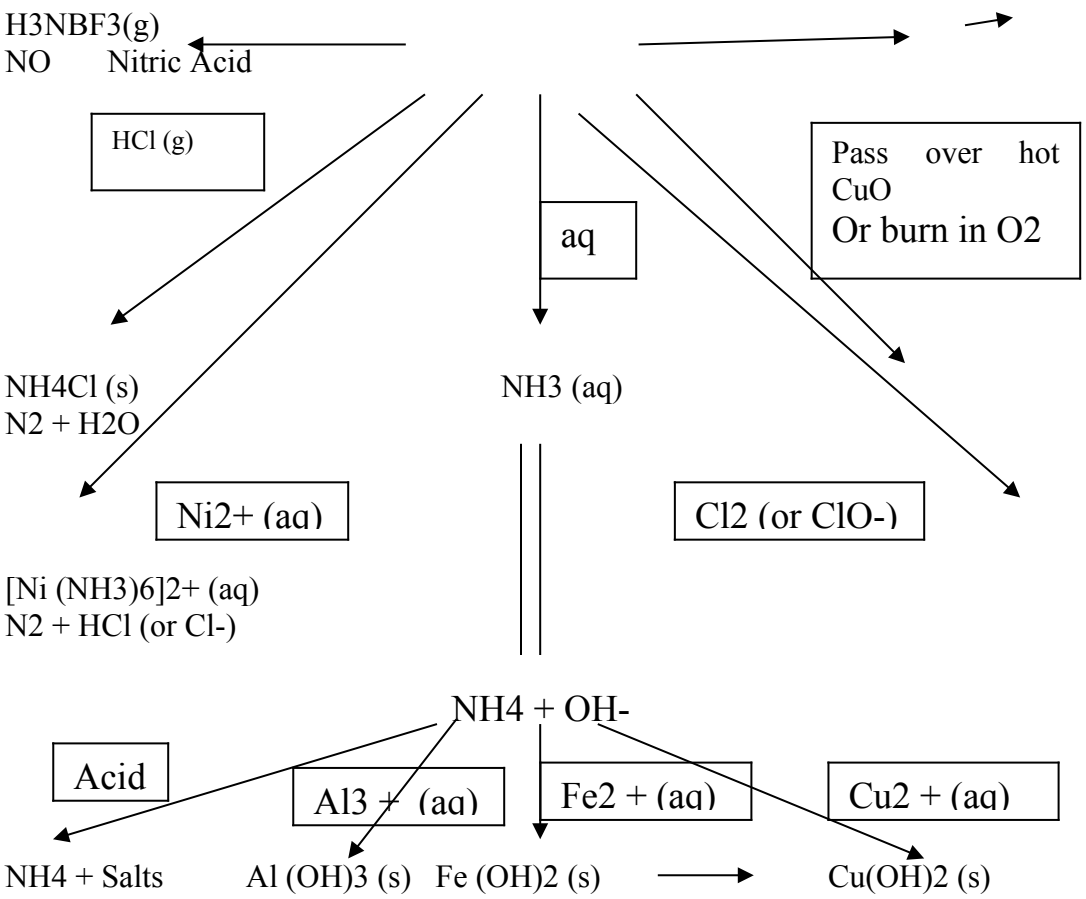


Figure 8: The Nitrogen Cycle:



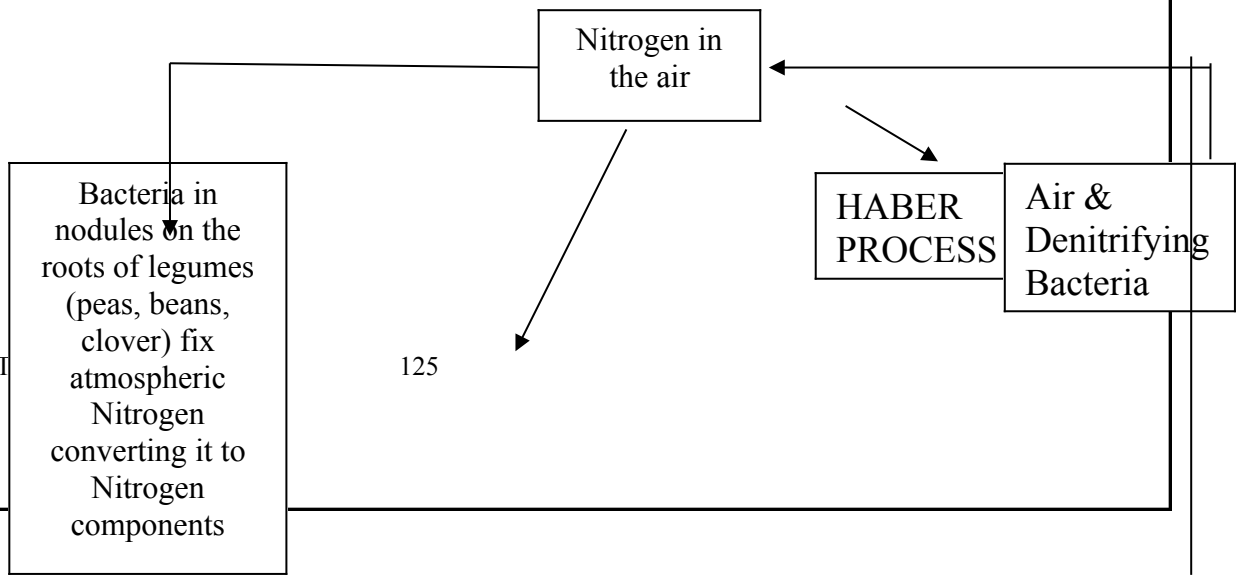


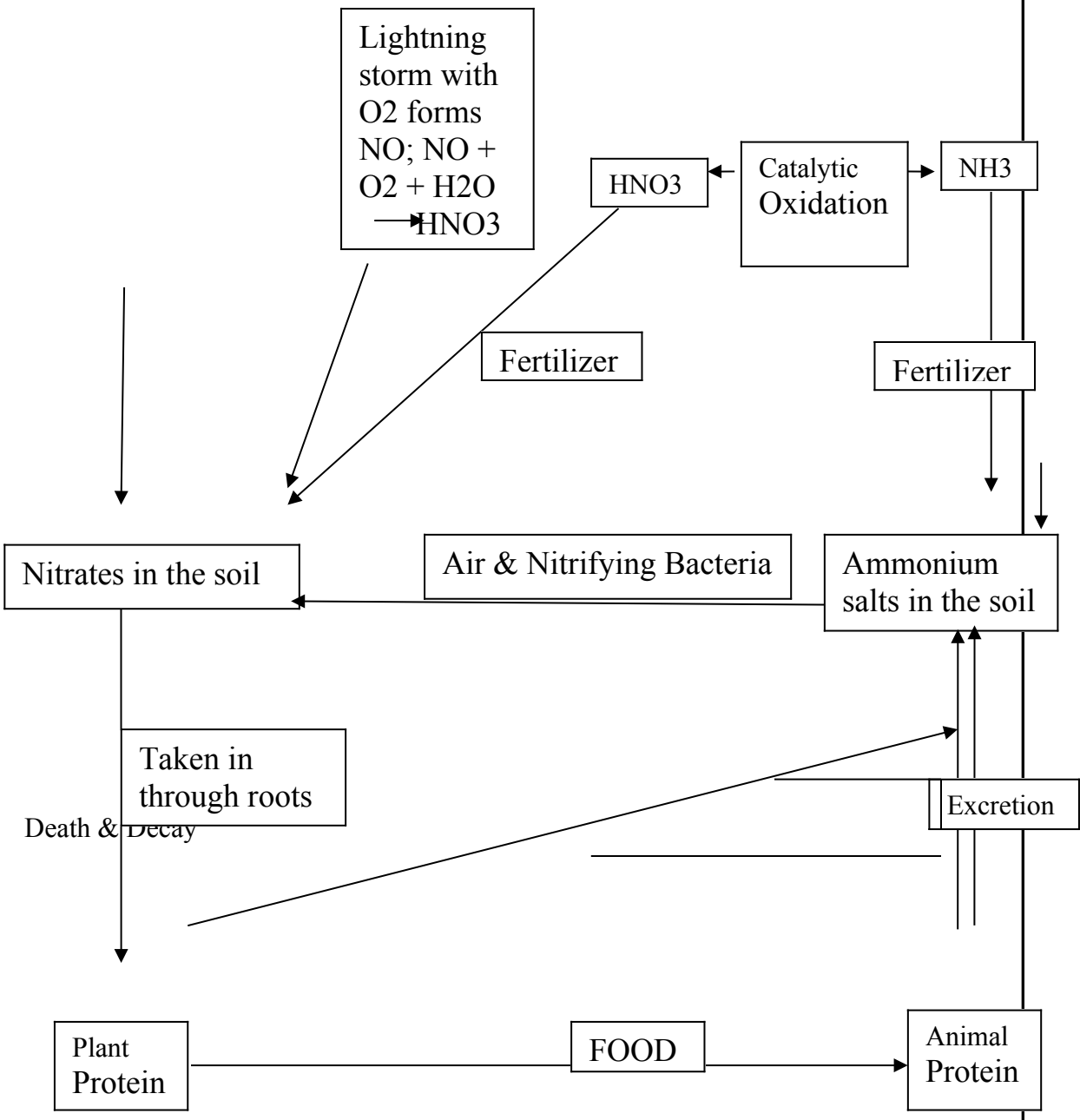
AMMONIUM SALTS ARE IMPORTANT FERTILIZERS
THEY ARE EASILY DECOMPOSED BY HEAT

$(NH_4)_2CO_3 (s) \rightarrow 2NH_3 (g) + CO_2 (g) + CO_2 (g) + H_2O (g)$

$NH_4Cl (s) \rightarrow NH_3 (g) + HCl (g)$

Figure 9: Nitrogen Cycle:


Nitrogen in the air
Bacteria in nodules on the roots of legumes (peas, beans, clover) fix atmospheric Nitrogen converting it to Nitrogen components
HABER PROCESS
Air & Denitrifying Bacteria



8.2 Nitrogen is 78 % by volume of dry air. It is an essential element in all living things. Nitrogen is a constituent of proteins and nucleic acids. Some Nitrogen is mined as Nitrate ores such as Chilenitre NaNO3

Dinitrogen consists of diatomic molecules

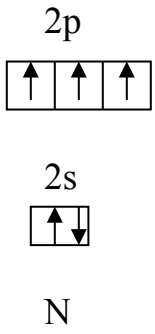
$$N \equiv N$$

Low reactivity of Nitrogen attributable to strength of triple bond.

$N_2(g) \rightarrow 2N(g); \quad H = +940 \text{ Kj mol}^{-1}$

Oxidation states of +3 and +5 in oxo-anions (+3 in NO_2^- and +5 in NO_3)

Covalency of 3, Nitrogen has no d orbitals, thus it cannot promote one of the s electrons to a d orbital. Thus covalency of 3 using the 3 unpaired p electrons.



When Nitrogen uses its lone pair of electrons to form a coordinate bond as in NH_4^+ and NO_3^- it has a covalency of 4.

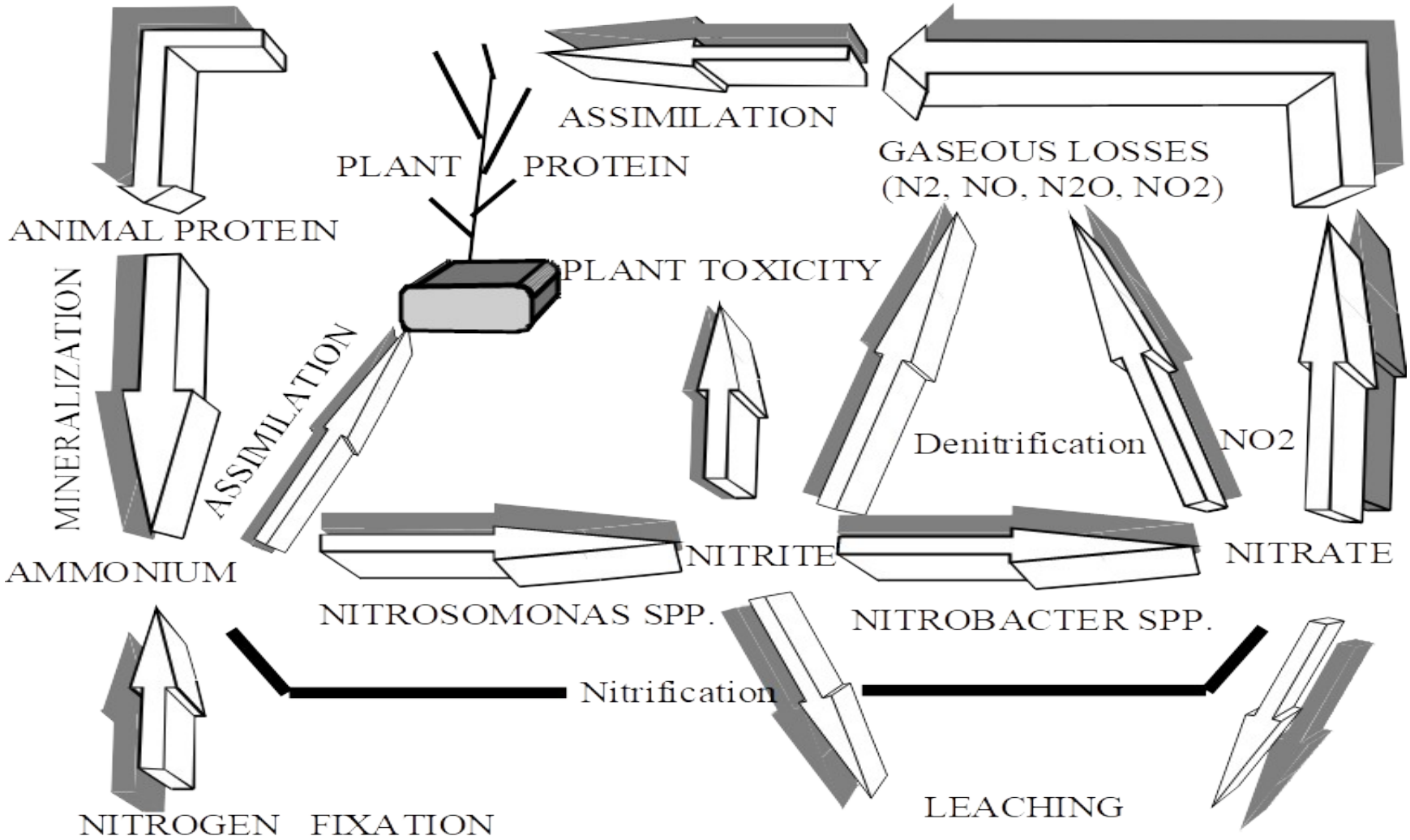


Figure 10: Schematic Nitrogen Cycle:

Figure 11: Schematic Pathway of Nitrogen in the Plant.

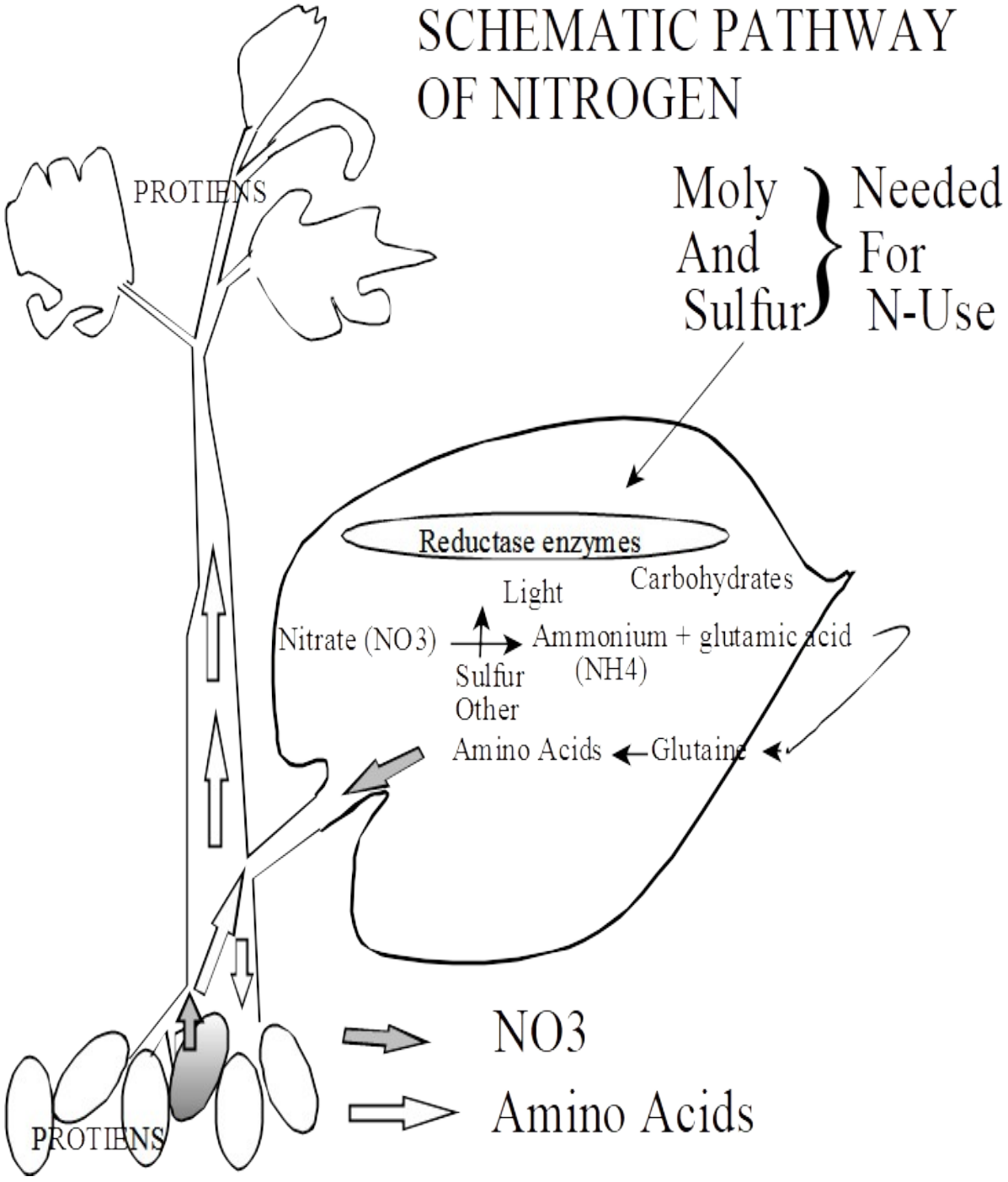
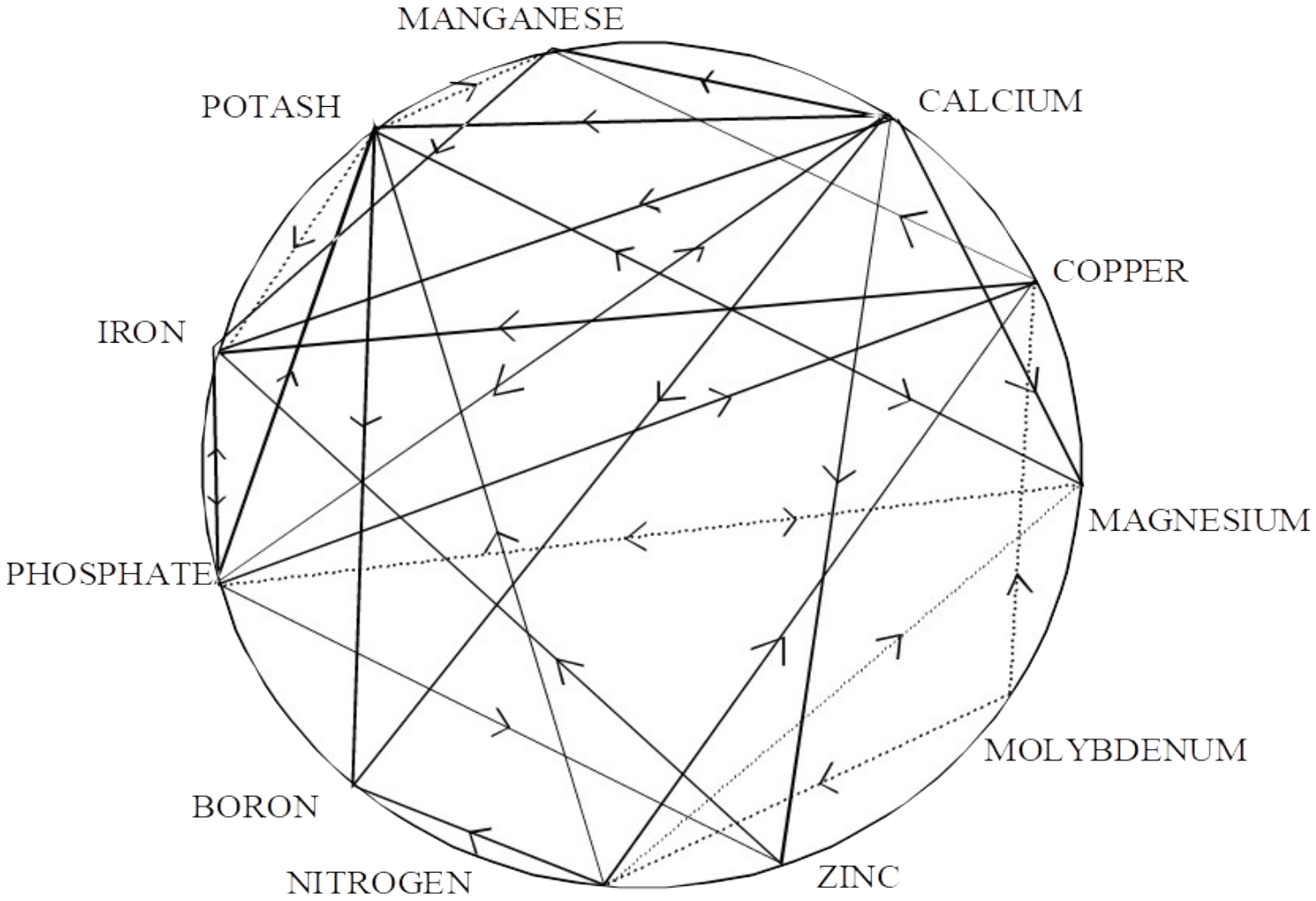


Figure 12: Mulder's Chart: Interaction Between Nutrients:

Mulder's Chart is a graphic illustration of the complexity of interaction between nutrients. Antagonism is illustrated by a solid line and stimulation by a dotted line.



8.4 Table 6: Nitrogen & Phosphorus Reactants:

REACTANT	NITROGEN	PHOSPHORUS
Metals	Ionic or interstitial Nitrides formed	Phosphides formed
Oxygen	Some NO formed At high temp. & in Electric discharge	Ignites, white at 35 C red at 260oC, to form P2O3 + P2O5
Sulphur	No reaction	Mixture of sulphides formed
Halogens	No reaction	PX3 + PX5 formed
Hydrogen	Some NH3 formed At high pressure	No reaction
Alkali	No reaction	White P (not red) reacts To form PH3 + H2PO2
Concentrated HNO3	No reaction	H3PO4 formed

8.5 Phosphorus:

Too reactive to occur in free state. Mined as phosphate ores e.g. Ca (PO4)2 Calcium Phosphate. When heated with silica and coke in an electric furnace, phosphorus sublimes over. The two chief allotropes of phosphorus are the white and red forms. The allotrophy is monotrophic, red phosphorus being more stable then white under all conditions. Oxidation states +3 and +5 in their oxo-anions.

+ 3 PO_2^-

+5 PO_3^- , PO_4^{3-}

Shows covalency of 3 using the 3 unpaired p electrons.

Shows covalency of 5 by promoting one of the s electrons to a d orbital.

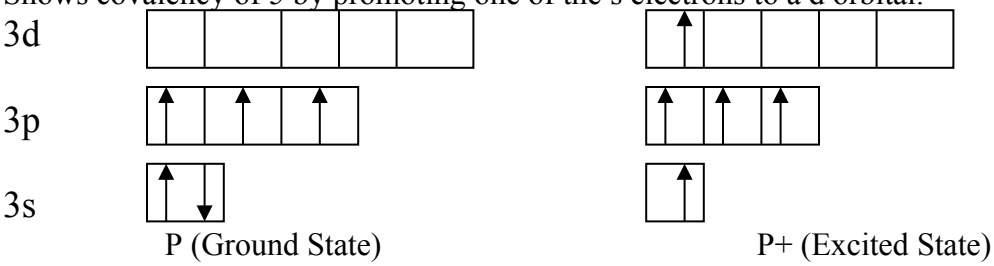
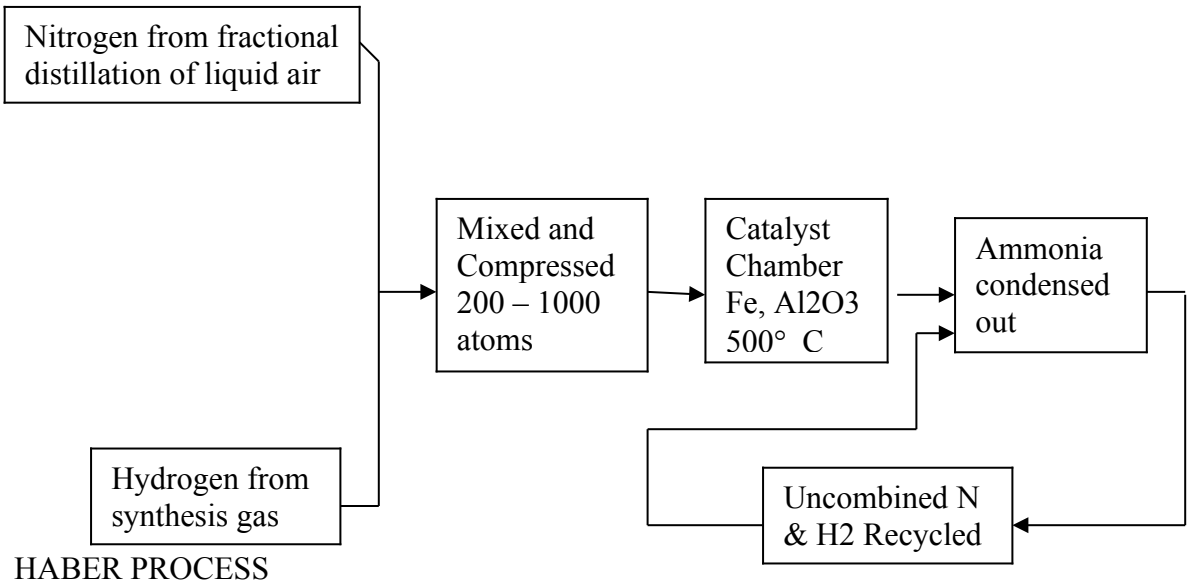


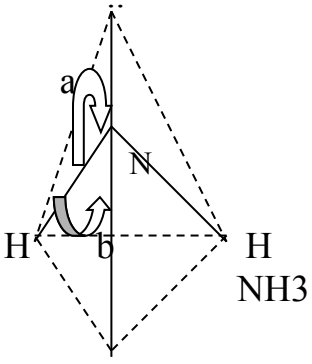
Figure 13: Ammonia.

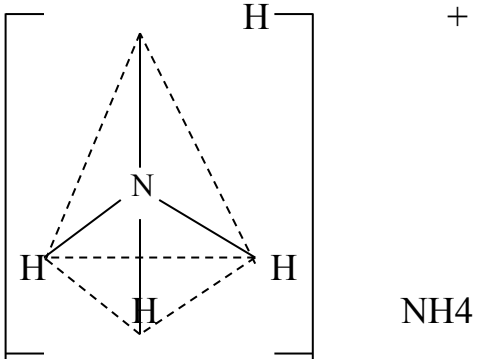

Nitrogen from fractional distillation of liquid air
Mixed and Compressed 200 – 1000 atoms
Catalyst Chamber Fe, Al2O3 500° C
Ammonia condensed out
Hydrogen from synthesis gas
Uncombined N & H2 Recycled

HABER PROCESS

$N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$; $\Delta H = -92 \text{ J mol}^{-1}$

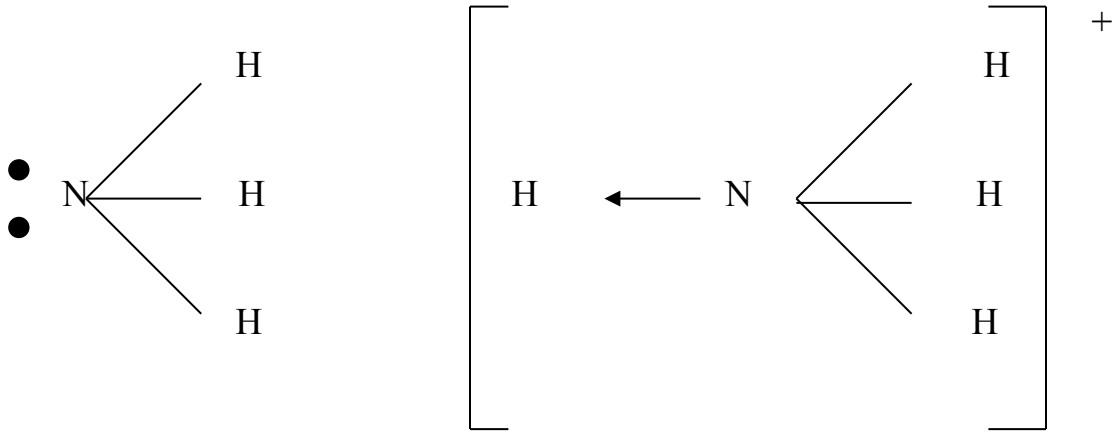
Exothermic reaction and involves a decrease in the number of moles of gas10 % yield
Ammonia is extremely soluble in water (1300 volumes per unit volume water) because it can form hydrogen bonds with water.
The arrangement of bonds in ammonia is tetrahedrol with the lone pair on the nitrogen atom occupying the 4th apex





Also CH4 & H2O

Four pairs of electrons around the central atom. Whether they are bonding pairs or lone pairs, they experience mutual repulsion. To minimize this, the four electron pairs orbitally adopt the spatial arrangement that maximizes the angle between orbitals. = four electron pairs adopt a tetrahedral configuration.



NH3 + H2O H3 O + OH-

The lone pair enables ammonia to act as a base, accepting a proton to form the ammonia ion NH4+

Ammonia is a Lewis base able to use its lone pair to form a coordinate bond to another molecule

9. ORGANICS:

Before going into details about Organics, we must examine Nitrogen a little closer.

9.1 NITROGEN SOURCE: Nitrogen is the most abundant element in Nature, it is an essential element in all living things, being present in proteins and nucleic acids. Nitrogen constitutes 78 % by volume of dry air. There are three types of Nitrogen that are applied to crops.

a. Ammonium (NH_4^+).
b. Nitrate (NO_3).
c. Urea ($NH_2 – CO – NH_2$)

9.2 It has been confirmed that excessive Nitrate levels in the soil leach down into ground water and cause brain cell damage in children. In advanced countries there are severe restrictions placed upon the uncontrolled use of Nitrate Nitrogen. Volatilization of Urea converts it into the Nitrate form in the presence of soil and water. Free living bacteria in the soil effectively convert most forms of Nitrogen into Nitrate form. Thus we find that both excessive Bacteria as well as Unstabalized Urea release Nitrates. In the plant, Nitrate Nitrogen causes excessive vegetative growth; decreases disease resistance; decreases drought tolerance and becomes toxic. In the soil Nitrate, being negatively charged, is subject to movement with soil water (Leaching).

9.3 EM Technology: The product Bio-Aab has been used and found to excellent for the production of quick compost. The bacteria use Nitrogen as a source of food and convert most forms to Nitrates. This is not harmful in so far as compost fertilizer is concerned. The bacteria effectively decompose the organic elements. Thus a process that would have taken up to a year, is shortened to 15 to 30 days. However it is not recommended that the material be used on the plants or for the soil. Excessive Nitrate will cause all the problems mentioned earlier.

9.4 Urea: Contrary to widespread belief, Urea is an Organic Compound manufactured from inorganic material. Urea, when used correctly, is a very useful compound. However being subject to Hydrolysis and Volatilization it will convert to Nitrate. The requirement is that Urea be stabilized to retain the Ammonium form (NH_4^+). This element being positively charged is not subject to leaching. Urea can be stabilized with Calcium Chloride (By product of Marble Industry) or with Sulfur. Both Calcium and Sulfur are required as Secondary Nutrients by the plant. Barani and Hilly areas are notoriously lacking in Sulfur. Calcium is used by the plant for disease resistance. Secondly Calcium being double positive charged, it repels the single positive charged Sodium ion and allows uptake of nutrients which were previously being blocked by sodium. The argument that stabilized urea will be costly is readily met with the answer that only 15 Kg of stabilized Urea is as good as 50 to 100 Kg of unstabalized Urea. Thus even if it is more expensive Stabilized Urea is certainly more cost effective. Secondly what can be better that the health of our future generations.

9.5 Recommendations:

9.5.1 Urea:

a) Immediate steps be taken to produce Stabilized Urea.
b) Split applications of stabilized urea be advocated.
c) Foliar application and banding of Urea be practiced.

The above measures will ensure a safe and steady supply of Ammonium Nitrogen as well as be cost effective due to decreased requirements resulting from efficiency.

9.5.2 EM Technology:

a) EM Technology should be adopted for use in composting.

9.5.3 Secondary & Trace Elements: It is a mistake to believe that Bacteria will make trace elements available in the soil. If there is an absence of a trace material it will not appear due to the action of Bacteria or any other element. It needs to be inculcated. This too is much more efficient if Chelated Secondary and Micro-Nutrients are used. This is a special process wherein the positively charged, pure divalent metals are covered by inert organic matter to promote bonding to the plant and restrict leaching.

9.6 Organic Fertilizer: The present times have, fortunately, revealed to us the importance of Organic content in our soils. The practices of the recent past, as related to Chemical Fertilizers, have brought about an Ecological Crisis in the making. There is no real antagonism between mineral (chemical) and Organic Fertilizers. Both are essential for immediate soil fertility, efficient soil conservation and flourishing biota. When well-composted Organic material and carefully selected and stable Mineral/Chemical Fertilizers are used, the productive capacity of the soil is enhanced. This results in increased speed of growth and weight of crops. At present we are concerned with Organic Fertilizers.

9.7 Organic Matter: Organic matter acts as a biological buffer ensuring that balanced supplies of nutrients are available to the plant roots. Soils that are poor in organic matter loose this buffering capacity and their fertilizer efficiency will decrease in N & P fertilizers.

9.7.1 Benefits:

a) Serves as the principal storehouse for anions such as nitrates, sulfates, borates, molybdates and chlorides that are essential for plant growth.

b) Increases CEC (Cation Exchange Capacity) of soil by a factor of 5 to 10 times that of clay.

c) Acts as a buffer against rapid changes caused by acidity; alkalinity; salinity; pesticides and toxic heavy metals.

d) Supplies food for beneficial soil organisms like earthworms, symbiotic Nitrogen fixing bacteria and mycorrihize (beneficial fungus).

e) Serves as recycling sink for organic waste and green manures (animal manure, crop residues, household refuse and leguminous plants collected within and outside the farm) and thus keeps environment clean and hygienic.

f) Softens the soil by introducing fibrous matter.

g) Increases soil water retention capacity.

h) Makes plants more resistant to pests and disease through improved nutrient availability and uptake, resulting in healthier plants with strong immune systems.

i) Prevents soil acidification.

9.7.2 In short organic matter greatly enhances nutrient availability, improves the biological functioning of the soil and the efficiency of chemical fertilizers (with increased efficiency less is required, thus reducing input costs).

9.7.3 Acidification is a process in which the H+ concentration of a soil system increases, resulting in a decrease in the observed pH. Intensive cropping, high yielding varieties and market production increases the demand for soil nutrients. Organic fertilizers and green manures cannot meet this demand because recycling organic wastes is only possible to a limited extent and green manures often compete with crop production.

9.8 Only organic matter inculcation or introduction of beneficial microorganisms will not suffice. Better understanding of soil mechanics should be used for mechanized soil management

and reduced tillage and even no-till be encouraged. This can only be done with increased organic matter in the soil. The best Technical and Financial option is often to use both organic and inorganic fertilizers. Studies have shown rice production of 7 tons per hectare using chemical fertilizers in traditional broadcast and 10 tons per hectare using bio-mass, safe and stabilized chemical fertilizers, liquid primary, chelated secondary and micro-nutrients, natural hormones and foliar applications. Yields of 5 to 6 tons were harvested per hectare using Organic fertilizer and some 14-14-14 chemical fertilizer. Organic fertilizer alone produced 4.5 to 5 tons per hectare. Where producing for the organic market, organic fertilizers and natural hormones can be used. Where producing for the conventional market, organic fertilizer, natural hormones, liquid primary, chelated secondary and micronutrients through split foliar and banding applications should be encouraged. Seed treatment, deep banding and good cultural practices will make all the difference in sustainability.

9.9 Humus: The decayed Organic Material such as plant and animal tissue constitutes humus. The chemical constituents of Organic residue decompose separately into cellulose; hemicellulose; strartches; sugars; oils; fats/ Proteins; amino-acids; amides; Lignin and undecomposed residues. The first group is attacked by microorganisms, releasing carbon dioxide and water, yielding intermediary substances; organic acids; alcohols and microbial cell substances; fats; waxes; hemicellulose etc. The second group (Proteins etc.) are decomposed directly by micro-organisms releasing Nitrates and Nitrites that combine with soluble Nitrogen compounds and yield microbial cell substances that eventually combine with fats; waxes; hemicellulose and Humus nucleus from proteins; Lignin and soil bases to form Humus.

The Natural process of forming Humus is lengthy and inefficient. However there is a method of hastening this process to produce ready to use Humus within 15 days.

9.10 Recycling Waste: Municipal waste; Fruit & Vegetable Market waste; Animal manure; Ashes and raw sewage not mixed with detergents and Household/ Commercial chemicals are generated in large quantities. It is estimated that a community of 10,000 people can generate 40-acre inches of sewage effluent per day or an equivalent of 1 million gallons of wastewater. This waste is extremely rich in nutrients especially Nitrogen. Large quantities of carbonaceous materials are present in Fruit and Vegetable Market waste. Fish Mundies and SlaughterHouse wastes are also valuable nutrient sources. The exchange of nutrients between living and non-living parts of the Eco-system is called Nutrient Cycling. When based upon human; animal and vegetable waste it is Nutrient re-cycling at peak efficiency rather than merely creating a nuisance; pollution and source of disease. The act of composting consists of two processes; Mineralization and Immobilization. Mineralization occurs when microbial decomposers convert the nutrients in Organic matter into inorganic ions. Immobilization is the uptake of inorganic nutrient ions by organisms. Thus nutrient cycling conserves the nutrient supply and results in repeated use of these nutrients. Organic matter added to the soil consists of many compounds. These are fats; carbohydrates; proteins and lignins. The process of Mineralization and immobilization eventually breaks down the most resistant elements for use of food. The net effect is the release of energy as heat; formation of carbon dioxide and water; and the appearance of Nitrogen as Ammonium (NH_4^+); Sulfur as Sulfate ($So^{=4}$); Phosphorus as Phosphate (PO_4^{-3}) and other Nutrients as simple metal ions (Ca^+; Mg^{++}; $K^=$). As the elements or ions are released in Organic Matter Decomposition; other specialized organisms oxidize some of them. The oxidized forms are more readily available for use by higher plants.

9.11 Composting Conditions: There are five conditions for composting. These are:

9.11.1 Mixture of Plant and Animal Material: The animal material supplies the Nitrogen, which is needed by bacteria. The Carbon component is supplied mostly from plant residue. The Carbon:Nitrogen ratio should be 20:1 for satisfactory decomposition. This balance can be struck by a rule of thumb of 1:30 ratio between manure to other organic materials.

9.11.2 Size of Material: The smaller the particles the faster the decomposition process as it yields greater surface area for bacteria. This is achieved by chopping and shredding.

9.11.3 Aerobic/ Anaerobic: This means in the presence of Oxygen and in its absence. Anaerobic decomposition kills pathogens; Insect eggs and seeds. It prevents creation of odor. Open air composting is quite the opposite.

9.11.4 Water: The decomposing materials should be wet like a sponge yet not dripping. This is achieved by 50 % of the solid volume being supplied as water.

9.11.5 Temperature: At first the temperature of the material should rise to 55-60 C, within a few days and then subsequently drop. This process results from correct mixing and is used as an indicator.

9.12 Constituents: The following material can be used for composting.

9.12.1 Grass other clippings.

9.12.2 Vegetable; Fruit; Kitchen waste.

9.12.3 Paper.

9.12.4 Raw Sewage.

9.12.5 Animal Manure/ Urine.

9.12.6 Municipal wastes (no plastic; metal; rags or glass).

9.12.7 Fine silt.

9.12.8 Ashes.

9.12.9 Dolomite.

9.12.10 Crushed Limestone.

9.12.11 Compost activator Herbs (Comfrey; Yarrow).

9.12.12 Bacteria.

9.12.13 EM – Bio Aab. Containing:

a) Photosynthetic Bacteria.
Rhodopseudomonos spp.

b) Lactic Acid Bacteria.
Lactabacillus spp.

c) Yeast.
Sacchoromyces spp.

9.12.14 Bio-Post. Carrying N2 fixing:

a) Pectionalytic.

b) Ligninolyutic.

c) Cellulolytic

d) Trace elements (Mg; Fe; Cu; B; Mn; Co; Mo).

All are recommended in order to produce high quality humus in the shortest period of time and occupy least amount of space.

9.13	Statistics:_	
9.13.1	Raw Sewage:	10 acre inches.
9.13.2	Green Waste:	15 trolleys.
9.13.3	Animal waste.	10 trolleys.
9.13.4	Municipal waste.	15 trolleys.
9.13.5	Silt.	2 acre inches.
9.13.6	Ashes.	2 acre inches.
9.13.7	Dolomite.	¼ acre inch.
9.13.8	Crushed Limestone.	2 acre inches.
9.13.9	Activator Herbs.	1 trolley.
9.13.10	Bacteria.	
	a) EM- Bio-Aab.	125 L base.
	b) Bio Post.	10 bags (500 Kg).

This material is introduced in layers from sr. 9.13.1 to sr. 9.13.10, in half quantities each and then repeated till all the material is used. Serial a) is introduced along with water; sugar source for the Bio Aab Base and 12,500 L of water. This material is placed in tanks covering 1 acre and covered by black plastic. The process is repeated every day for 15 days in adjoining acres to make a total of 15 acres. Each filled acre is turned over after 7 days and re-covered. After 15 days (in summers), the first batch is ready for bagging (due to low temperatures of Abbottabad winrters composting will take from 2 to 3 months). The produce is 4 trolley loads at an estimated cost of Rs.3,700.00 per trolley, less labor and machinery costs. If sold at Rs.5,000.00 per trolley, labor and machinery costs can be retrieved. Thus we have a ready for use Nutrient recycled Fertilizer as well as cover the nuisance of mounds of rotting garbage.

9.14 This same procedure can be adapted for small scale farm yard composting at a much lower price. Thus the needs of the farmers can be met on farm. The huge quantities of Humus produced can be used in City gardens; Nurseries; Potted Vegetable growing etc. This material can also be exported to the Middle East. It is urged that the matter be investigated and adopted at the earliest.

CHAPTER 5: ON-FARM SOIL & WATER CONSERVATION[1]:

1. INTRODUCTION: It is essential to understand that there is a need for conserving the soil in order to ensure continuos productivity. It is only by efficient use and management of soil that its productiveness can be maintained over an extended period of time.

1.1 The use and management of soil includes:
1.1.1 Planning, in order to determine proper use.
1.1.2 Preparation of soil for planting.
1.1.3 Treatment of soil for the production of plants.
1.1.4 Complete plant nutrition and care.
1.1.5 Proper harvest and post-harvest practices.

Water is a precious, natural, renewable resource and the basis for all life. It must be treated with care and long term planning in order to ensure, as much as humanly possible, that it is, and remains, available to nurture all living things.

1.2 The District of Abbottabad is very much in need of Soil & Water Conservation Measures for the farm, such as:
1.2.1 Conservation Planning.
1.2.2 Land Resources Inventory.
1.2.3 Crop Rotation.
1.2.4 Contour Farming.
1.2.5 Strip-Cropping.
1.2.6 Terracing.
1.2.7 Farm Drainage.
1.2.8 Gully Control.
1.2.9 Aquifer Recharging.
1.2.10 Water Harvesting.
1.2.11 Grass Waterways.
1.2.12 Watershed Management.
1.2.13 Conservation Irrigation.

If a realistic and pragmatic view is taken of our present circumstances we are bound to come to rather disappointing conclusions. The good news is that there is tremendous scope of improvement and enhanced productivity. Our negligent and harmful practices are under-utilizing what could be bountiful and abundant productivity. The severity of the present problems has been reduced largely due to the Governments Green Revolution of the 1960s. The time has now come to initiate a Grass Roots, Green Revolution. This can only be done through realistic planning and concentrated implementation. The use of locally produced modern, Hi-Tech, yet low cost materials can substantially reduce the negative impact of many of our problems. There is absolutely no point in being Technology Shy! Plant Nutrition, as detailed previously, through the use of 21st Century Nutrition products is one such step. Another step, that can and should be introduced, is the use of Anionic Polymers or Polyacrylamides, for reducing soil loss through erosion. Soil losses have been reduced to as little as 2.3 megagrams per hectare, as compared to 101 megagrams per hectare on treated and control plots respectively[2]. The effects of Polymer

[1] Most of the material in this chapter has been derived from the Course material of a Diploma "Master Conservation" of the North American School of Conservation, Scranton, PA, U.S.A.

[2] Laboratory of Biomedical and Environmental Sciences, University of California, Los Angeles, 1986. Wallace and Wallace.

Concentrations on Furrow Irrigation have shown that over a range of application rates, of at least 0.7 Kgs/ hectare and mean of 1.3 Kgs/ hectare, there was a furrow sediment loss reduction by 94 % and increase in net infiltration by 15 %[3]. Yet another step, that has achieved amazing results in the United States in the 1930s, was the formation of Conservation Districts. We can easily duplicate this success by undertaking similar efforts. While the proposed methodology is detailed elsewhere, some important steps that can be undertaken follow.

2. CONSERVATION PLANNING: The basic wealth of any Country is its Natural Resources. These are divided into renewable and non-renewable. A just and equitable use of these resources is a rational use that provides benefits to all and ensures that this use is sustainable. This means using without using up. Ensuring that Natures abundance is not abused and only used in such a manner that it continues to provide its living abundance to all coming generations. We are presently concerned with two of the three major renewable resources. These are the soil and water. Our present and past usage of these resources leaves much to be desired. The Ecological Systems that sustain us are inter-linked and fragile. Thoughtless over exploitation renders them subject to degradation and eventual failure. Some of the immediate threats we are facing, in Abbottabad District, due to our negligence are:

2.1 Soil erosion.
2.2 Decline in soil fertility.
2.3 Increased soil borne pests.
2.4 Denuded Watersheds.
2.5 Ravaging flash floods.
2.6 Increasing aridity.
2.7 Receding Water Tables.
2.8 Climate change.

This results in reduced agricultural capacity, while population pressures continue to mount. To overcome these grave problems it is all the more necessary to make detailed and realistic plans for proper soil and water use and their consequent rejuvenation. Subsequently it is imperative that these plans be carried out in letter and spirit. The first conclusion that is drawn from any preliminary survey of the Districts Land and Water usage is that it is inappropriate to say the least. Primary data, that has been collected, supports this statement. In order to come up with a realistic Conservation or Sustainable Development Action Plan the first step is to make a Land and Water Resources Inventory. This is subdivided into Land and Water.

3. LAND INVENTORY: It is important to keep in mind the reason of making a Land Inventory. This is to provide the requisite Primary data that will enable maximum and rational use of every acre of land within the District. Maximum in terms of economic returns that keeps in mind limited resources. Rational in terms of harmony with Nature and sustainability for coming generations. A Land Inventory is the first step towards ascertaining Land capability. This amounts to mapping the land to show:

3.1 Kind of soil with respect to:

3.1.1 Soil Characteristics:

(a) Effective soil depth.
(b) Texture of topsoil.
(c) Soil permeability.

[3] Lentz and Sojka. US Dept. of Agriculture, Idaho, 1994.

(d) Type of parent material.

3.1.2 Land Characteristics:

(a) Slope.

(b) Degree of erosion.

(c) Wetness of soil.

3.2 Effective Soil Depth.

Depth of a soil, down to a restrictive layer such as bedrock or hard pan, is known as Effective Soil depth. This is the depth to which plants roots can penetrate and moisture can be stored:

Table 1: Effective Soil Depths:

Sr	Range	Descriptive Term	Symbol
1	> 60 inches.	Very deep	1
2	36 - 60 inches.	Deep	2
3	20 - 36 inches.	Moderately deep	3
4	10 - 20 inches.	Shallow	4
5	0 - 10 inches.	Very shallow	5

Soil depth is determined with the help of a soil auger.

3.3 Texture of topsoil: The surface 6 to 8 inches of soil is called the topsoil. This is the depth that is normally worked in soil tillage operations. Soil texture is a good indicator of soil erodability and rate of infiltration of water into the soil. The relative proportions of the various size groups of individual soil grains in a mass of soil are the benchmark of soil texture. Silt, clay and sand with less than 2-mm diameter are considered. The amount of these three materials in a representative soil sample determines its texture class. The higher the percentage of sand the lighter the soil and as silt and clay content increases, the soil becomes progressively heavier.

Table 2: Topsoil Texture:

Sr	Textural Class	Descriptive Term	Symbol
1	Heavy clay.	Very fine (very heavy)	V
2	Clay, silty clay, sandy clay, silty dry loam, clay loam.	Fine (heavy)	H
3	Clay-loam, silt-loam, loam, very fine sandy loam.	Medium	M
4	Fine sandy loam, sandy loam, loamy fine sand.	Coarse (very light)	L
5	Loamy sand, sand, coarse sand.	Very coarse (very light)	C
6	Well decomposed organic soil.	Muck	O
7	Undecomposed organic soil.	Peat	P
8	Texture classes not separated.	Undifferentiated	X

The occurrence of coarse fragments in a soil, in sufficient quantities to influence land use, sometimes necessitates further modification of textural classes. These are represented by lower-case letters, which precede the above upper-case symbols.

Table 3: Topsoil Texture Modifiers.

Sr	Size Range	Descriptive Term	Symbol
1	Fragments up to 3 inches in diameter.	Gravelly	g
2	Fragments 3 to 10 inches in diameter.	Cobbly	c
3	Fragments more than 10 inches in diameter.	Stony	s
4	Rock outcrops of the bedrock.	Rocky	r

3.4 Soil Permeability: This is defined as the ability of air and water to move through a soil. Infiltration rate is the rate at which water enters a soil from the surface. As opposed to this soil permeability is measured as the amount of water that will pass through a column of saturated soil, of a given cross-section, under a specific hydraulic gradient, in a unit of time. The number that represents soil permeability is related to the rate of water movement through that soil under the top 10 inches. This number gives the soil permeability up to a point where a different zone of permeability exists. This zone is not to be confused with the zone that restricts root penetration and is restricted to the effective soil depth. Therefore in case such a zone exists in the soil under examination, two numbers are given representing the two permeability zones. In cases of deep surveys, for example those required for drainage systems, a third number is given. In such cases the first number will represent permeability at a depth of 10 to 36 inches, the second at a depth of 3 to 5 feet and the third will represent permeability from 5 to 9 feet.

Table 4: Soil Permeability:

Sr	Rate inches per hour	Probable texture	Class	Symbol
1	< than 0.05	Very fine or fine	Very slow	1
2	0.05 to 0.2	Very fine or fine	Slow	2
3	0.2 to 0.8	Fine or medium	Moderately slow	3
4	0.8 to 2.5	Medium	Moderate	4
5	2.5 to 5.0	Coarse	Moderately rapid	5
6	5.0 to 10.0	Very coarse	Rapid	6
7	> than 10.0	Very coarse and gravelly	Very rapid	7

3.5 Parent Material: Primary soils are those that have been formed by soil forming processes from the underlying material. In the case of primary soils, the underlying parent material is always shown, regardless of depth. Secondary soil is that soil that has been formed from soil material that has been transported from some other location by wind or water.

Table 5: Underlying Material:

Sr	Material	Symbol
1	Acid crystalline rock	A
2	Basic crystalline rock	B
3	Serpentine	C
4	Loess	D
5	Shale, fine-grained sedimentary rock	E
6	Sandstone, coarse-grained sedimentary rock	F
7	Glacial material	G
8	Limestone	L
9	Muck	M
10	Peat	P
11	Sand	Q
12	Cemented hardpan – including hard caliche	R
13	Semi-consolidated alluvium	S
14	Lacustrine material	V
15	Claypan	Y

16	Gravel	Z

3.6 Slope: Soil and Water Conservation is influenced to a large extent by the degree of slope of the land. Slope is represented in percentage and this has been grouped according to influence on erosion and water. A one- percent slope means one foot vertical drop for 100 feet horizontal distance.

Table 6: Slope of Land:

Sr	Slope Range in Percent	Descriptive Term	Symbol
1	0 to 2	Nearly level	A
2	2 to 5	Gently sloping	B
3	5 to 9	Moderately sloping	C
4	9 to 16	Strongly sloping	D
5	16 to 31	Moderately steep	E
6	31 to 51	Steep	F
7	51 to 76	Very steep	G
8	76 plus		H

Slope of land is usually measured with a hand level. Slopes are not always uniform and as such do not always fall into the ranges given. In such case it is possible to combine two or more symbols, e.g. CD or a slope that ranges from 5 to 16 percent. In cases where slopes are uniform the symbol can be preceded by the exact percentage, e.g. 8C.

3.7 Soil Erosion: Soil erosion refers to removal of soil by natural forces such as water or wind. The degree of erosion is classified by studying the soil profile and by degree of gullying that has occurred.

Table 7: Degree of Erosion:

Sr	Range	Descriptive Term	Symbol
1	< 25 % of original topsoil or original plowed layer removed.	No apparent, or slight, erosion	1
2	25 to 75 % of original topsoil or original plowed layer removed; occasional gullies may be present.	Moderate erosion	2
3	From 75 % of original topsoil to 25 % of subsoil removed; occasional deep gully or frequent shallow gullies may be present.	Severe erosion	3
4	All original topsoil and 25 to 75 % of subsoil removed.	Very severe erosion	4
5	Intricate network of very frequent gullies.	Very severe gullies	5

3.8 Degree of Wetness: Degree of wetness is the amount of free water within the normal root zone. Where it interferes with normal plant growth, it is taken into consideration. Water in the root zone may be the result of slow drainage or due to a fluctuating water table. This should not be confused with soil permeability, as a soil with good permeability may be wet due to poor underlying drainage.

Table 8: Degree of Wetness:

Sr	Range	Descriptive Term	Symbol
1	Choice of crops slightly limited, or planting dates slightly delayed	Slightly wet land	W1
2	Crops are moderately affected or planting dates delayed	Moderately wet land	W2
3	Crops seriously affected or delayed	Very wet land	W3
4	Swamp or marsh; too wet for cultivated crops	Extremely wet land	W4

Some land is subject to overflow at varied intervals and for varied periods of duration. Frequency of this action and length of duration may affect farming operations. In such cases it is included in the Land Inventory.

Table 9: Frequency of Overflow:

Sr	Range	Descriptive Term	Symbol
1	Crops occasionally damaged or planting delayed	Occasional overflow or of short duration	f1
2	Crops frequently damaged or range of crops limited	Frequent overflow or of long duration	f2
3	Growing of cultivated crops not feasible	Very frequent overflow or of very long duration	f3

3.9 Standard mapping Symbols: The symbols shown above are standard, in order to overcome any possibility of confusion. Further they are represented on the map, in a standard manner, as a fraction symbol. Soil characteristics are shown as the numerator and land characteristics as the denominator.

Soil:

Slope - Erosion

From a Land Inventory it is possible to determine the ability of the land to produce and the type of action that must be taken to protect it or enhance its productivity.

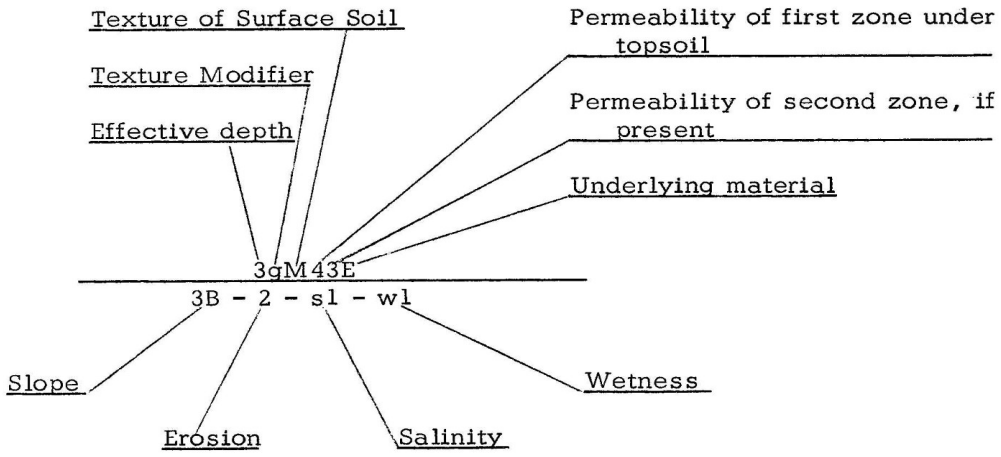


Figure 1: Standard Mapping Symbols.

4. LAND CLASSES: Land classes are divided into two main categories:

4.1 Suitable for Cultivation.
4.2 Not Suitable for Cultivation.
These are further divided into sub-categories:

4.1.1 Class I: Deep, nearly level land that is not easily erodable. Suitable for all types of crops as determined by limiting factors like climate and light intensity.

4.1.2 Class II: Good land with moderate limitations. Any one of the factors that are determined by the Land Inventory and less than ideal, cause this distinction.

4.1.3 Class III: Moderately good land that can be cultivated with regular crop rotation.

4.1.4 Class IV: This is land where long rotation between pasture and grain crops should be maintained on a 3 – 4 year basis.

4.2.1 Class V: These may be level and not subject to erosion but may be unsuited to cultivation due to limiting factors as determined by the Land Inventory.

4.2.2 Class VI: These may be somewhat limited to pasture or forest because of shallow soils or steep slopes.

4.2.3 Class VII: These have severe limitations for pasture or forestry.

4.2.4 Class VIII: These lands are not suited for cultivation, pasture or forestry.

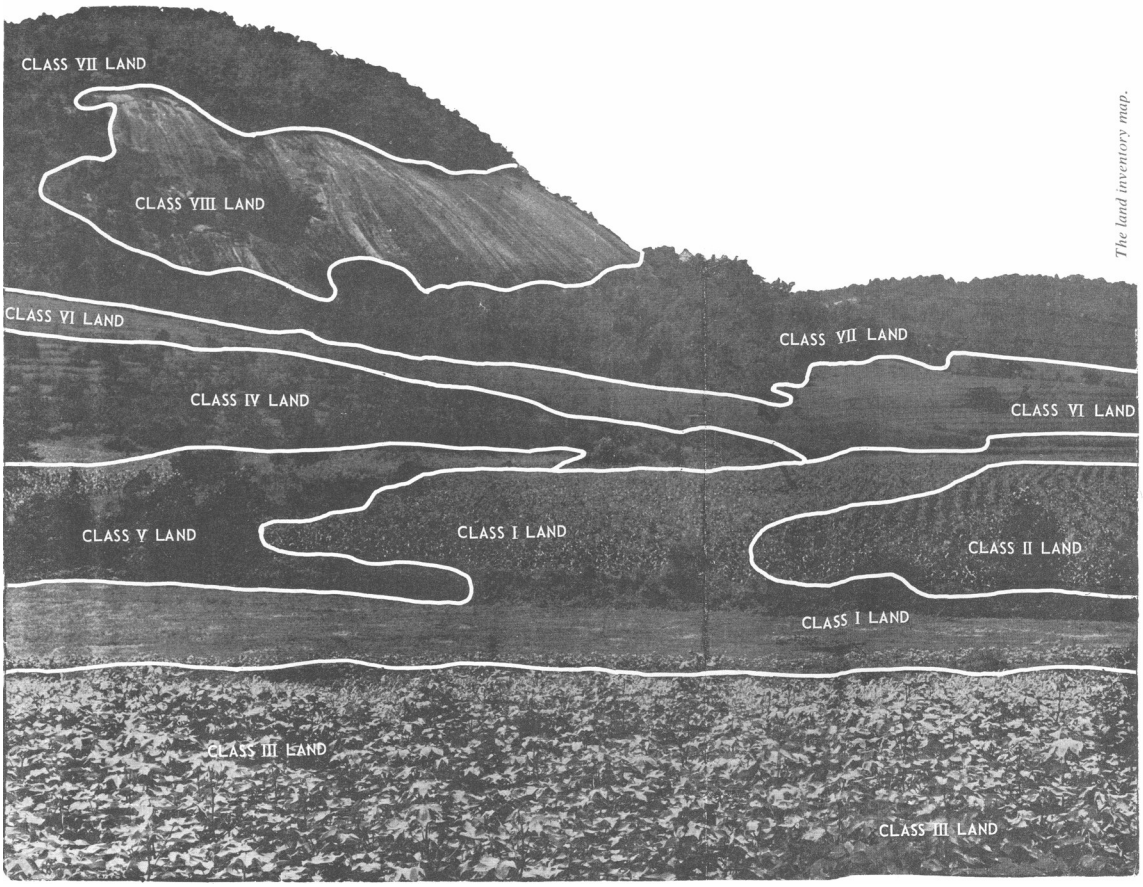


Figure 2: Land Classes.

5. CROP ROTATION: The growing of different crops in succession on the same land is called crop rotation.

5.1 The benefits of crop rotation are:

5.1.1 Reducing soil erosion: Row crops which are placed 24 to 48 inches apart require frequent cultivation and leave little or no crop residue. The exposed soil between rows is subject to erosion. Less distance between rows and more crop residue left behind, decreases soil erosion. When different types of crops are grown on a piece of land in succession the overall result is lesser erosion.

5.1.2 Improving yields: Different types of crops make different demands upon the soil or fertilizers required. They also leave behind different types of residue. For example a leguminous crop will leave behind a surplus of fixed Nitrogen. The soil will benefit from these demands and supplies made by various plants. When this factor is used intelligently, i.e. fertilization and rotation by carefully selected or recommended crops, the soil will benefit and productivity will be enhanced.

5.1.3 Disease, insect and weed control: Different types of crops are host to various kinds of pests and are subject to different types of diseases. Where monoculture is practiced these pests and diseases get the opportunity of finding a constant host. Where rotation is practiced this is obviated and pest's life cycles are interrupted. Different types of cultivation and weeding requirements also interrupt the seeding of weeds.

5.2 There are many factors involved in the choice of a cropping system for a particular piece of land. Cropping systems should be flexible and permit change of acreage of crops from year to year. Obviously, financial considerations are additional to physical limitations.

5.3 The planning of a cropping system requires three questions to be borne in mind:

5.3.1 What properties of the soil, in a field, require particular attention, in order to ensure efficient production, while maintaining or enhancing soil productivity in the long term?

5.3.2 What different methods can be used to control crucial soil factors?

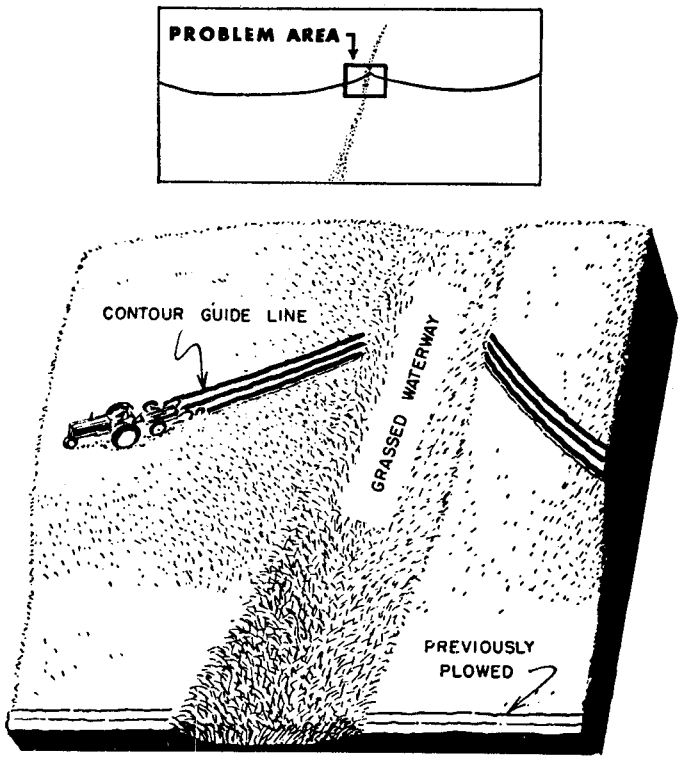
5.3.3 What crops will fetch the highest returns and yet allow attention to the above questions?

6. CONTOUR FARMING: The practice of plowing and planting across, rather than up and down, the slope is termed as Contour Farming. The objective of such an exercise is to conserve soil and water. In arid areas this practice results in slowing down runoff and allowing it to soak into the soil. In humid zones this results in preventing soil loss. This practice results in better yields. This is due to the fact that increased moisture content in the soil, even in humid zones, provides moisture to the plants during lean or drought periods.

6.1 Key Contours: In order to be able to plow along the contour the farmer needs one, or more, key contour lines on each field. The purpose of a key contour is to guide the farmer in the plowing operation. In the case of short slopes, one key contour line halfway down the slope is sufficient. In the case of long or irregular slopes, several key contour lines may be needed. The laying out of key contour lines is a relatively simple operation. All that is required is a hand level and a few stakes. The first step is to determine which portion of the helpers body (shoulder, chin or hairline) is the sighters eye level, when both are standing on level ground. When sighting through the level, if the hairline is against this portion of the helper's body, both are standing at the same elevation. The next step is to choose a key contour. A stake is driven into the ground

and the level is set up. The helper moves along this contour in as much a level course as possible. When he has traveled the predetermined distance, the sighter looks through the level. He signals any adjustment in the helpers position that may be required. When the sighter is satisfied he signals the helper and the next stake is driven into the ground. The sighter then moves to the position of the new stake and the process is repeated until the line is completely established. In case the contour line crosses a waterway, it should stop and not disturb any vegetation. Once all stakes are driven the line can be established by plowing.

6.2 Contour Tillage: This is one of the simplest practices to conserve water and soil. It is most effective on slopes from 2 to 8 % and reduces soil and water loss from 20 to 40 %. This practice is also effective in improving Rangelands. Where grasses have deteriorated to short, soddy growth it has been found that contour tillage with furrows 4 to 6 inches across and not more than 5 feet apart, improve the vegetative growth. If higher grasslands undergo contour tillage the effect on neighboring low land is reduction of silting from 85 to 95 %.



Do not continue plowing the contour line across a waterway.

Figure 3: Contour Tillage.

7. **STRIP-CROPPING:** If sloping land is left bare during the rainy season, it is subject to erosion. Such land is best protected by strip cropping. A farmer can plant his crops in large blocks or complete strips. On the other hand it is advisable to divide the fields into narrow strips. This is done in order to protect clean-tilled strips of corn with non-cultivated strips of small grain or hay. Large sloping fields that are plowed and cultivated at the same time are subject to the maximum amount of erosion during the period when no crop has yet grown. A viable alternate is to plow and cultivate alternate strips. This

ensures that erosion-resistant crops are growing between clean-tilled areas. It is then possible to practice crop rotation and use all standard soil conservation practices in order to ensure minimum erosion.

7.1 Strip-Cropping Vs Contour Tillage. Strip-cropping is a vegetative form of soil erosion control as opposed to the mechanical method of Contour plowing. The two methods are roughly similar in water conservation but strip-cropping is by far better in soil conservation. The effectiveness of strip-cropping depends upon the plants that are grown in the strip. Sodded grasses are the best soil conservation plants. However, there is no financial return offered. The legumes and hay crops are the best financial alternate. Legumes hold the added advantage of fixing Nitrogen and hay crops provide fodder for Cattle.

7.2 Types of Strip-Cropping:

7.2.1 Contour Strip-Cropping: This type is a combination of Strip-Cropping and Contour Plowing. Crops are planted in strips, placed crosswise to the slope and following the contour. Dense erosion-control crops alternate with clean-tilled erosion permitting crops.

7.2.2 Field Strip-Cropping: In undulating slopes, with no true contour, the method of field strip-cropping is used. Here the crops are planted in strips, in roughly uniform parallel rows, laid crosswise to the general slope.

7.2.3 Wind Strip-Cropping: Here crops are planted in strips, crosswise to the prevailing wind, without regard to the contour of the land. This method is recommended on level to nearly level land, where soil erosion and water conservation are not a problem but wind erosion is the factor that needs attention.

7.2.4 Buffer Strip-Cropping: A sod crop, made up of grass or legumes, or a mixture of both, when planted between strips, in regular rotation, is called buffer strip-cropping. These buffer strips are usually laid on those portions of a slope that are badly eroded and not suitable to regular cultivation.

7.3 Managing Strip-Cropped Fields: Careful planning and installation of strip-cropping will enable permanently maintained fields. It is necessary to alternate the method of plowing in order to avoid build up of high ridges over the years. Turning the land up the slope is also desirable, in order to allow seeping of water under the furrow slice. This is done by using a two way turning plow to turn all the furrows in one direction. In case strips are irregular in width and both sides are approximately on the contour, planting should be done from both edges inwards to the center of the strip. This enables the placing of the greatest number of long rows on the contour and the short rows in the center. Regular rotation, except on strips most prone to erosion, should be carried out. It should be kept in mind that the denser the vegetation and the longer the crop stays on ground the less the danger of erosion. Plants with extensive root systems, like small grains, are better placed to protect the soil. Perennial legumes have dense vegetation and a fibrous root system that results in a dense sod. This provides the most protection. In humid areas where row crops are alternated with small grains, the former are planted up slope of the latter. This is done because the row crops require deeper furrows and higher ridges. This provides some protection against erosion. The small grains do not have this advantage and the soil is subject to erosion until they emerge.

7.4 Computing Strip Acreage: In order to determine the yield per acre it is necessary to know the amount of acreage that is planted for a particular crop. This is relatively simple in large block fields. In the case of strips, the following chart is used for computing acreage. This is done by knowing both the average width and length of the strip. Locate each point on the two sides of the

chart and draw an imaginary line between them. The point where this line intersects the central acreage line, is the acreage of the strip.

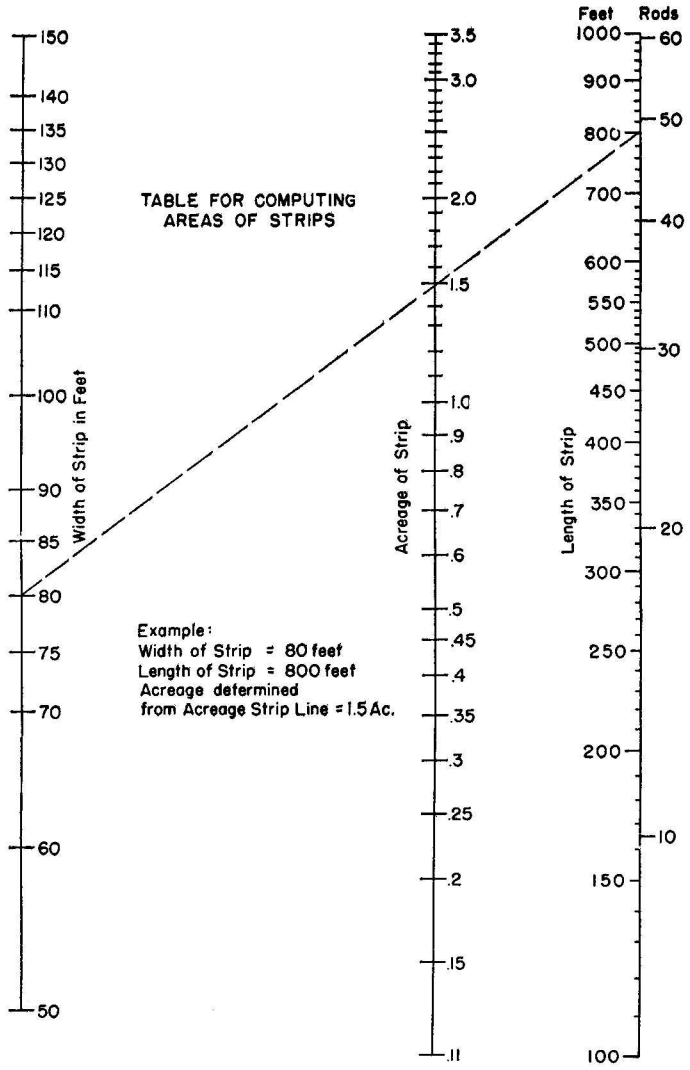


Table for computing acreage of strips.

Figure 4: Computing Strip Acreage.

7.5 Advantages of Strip-Cropping: This practice has been demonstrated to be a very economical system and a practical means of preventing, or reducing, erosion and water loss on cultivated land. There are many advantages in Strip-cropping and this practice is highly recommended for Abbottabad District. Some of these advantages are:

7.5.1 Reduced length of slope down which water runs retards the momentum of water.

7.5.2 Slower momentum increases infiltration and shedding of soil particles.

7.5.3 Dense vegetation growing in alternating strips further retards water momentum.

7.5.4 Soil is opened by root systems and earth worms. Dense vegetation on the sod strips prevent silting of these pores.
7.5.5 Strip-Cropping results in a large number of small fields, which in turn encourage crop rotations.
7.5.6 Installation of strips is not expensive.
7.5.7 Maintenance of strips is low.
7.5.8 Degree of accuracy, as required for terraces, is not as high. Mistakes can be rectified on the next plowing.
7.5.9 Time and energy are conserved as long strips are easily plowed, with fewer turns involved.
7.5.10 Less power is used when plowing across a slope rather than up and down.
7.5.11 Reduced runoff results in reduced loss of plant nutrients, resulting in turn, in higher yields.

7.6 Measuring the Slope: A few simple tools can give us an accurate estimate of the slope of a land. These are a yardstick, a straight piece of stick exactly 50 inches long and a carpenters level. The method is as follows:

7.6.1 Lay the stick on the slope.
7.6.2 Raise the lower end until the stick is level as shown by the carpenters level.
7.6.3 Measure the vertical distance from the downhill end of the stick to the surface of the ground.
7.6.4 This reading, in inches, when multiplied by two gives the percent slope.
In the case of regular slopes a single reading is sufficient. In the case of irregular slopes it will be necessary to obtain several readings and compute the average.

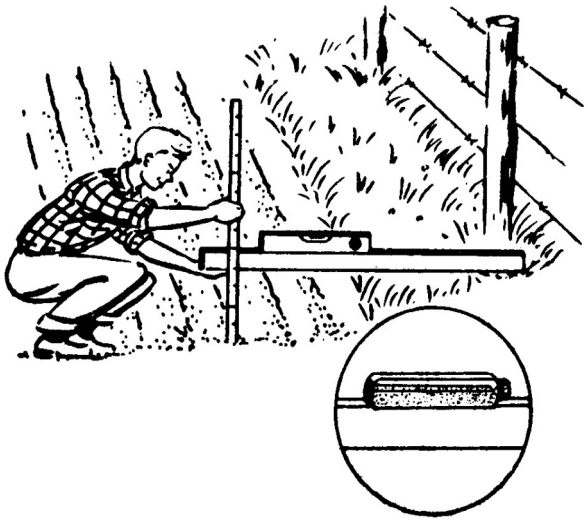


Figure 5: Measuring the Slope.

8. **TERRACING:** The basic function of a terrace is the interception of water. This water is either slowly absorbed in the field or slowly conducted from the field. In areas with less than 30 inches of rainfall the terrace is built to allow interception into the soil rather than run off the surface. A graded terrace will intercept the flow of water before it can reach a velocity that is high enough to damage the land. In level terraces, water is held

until it can soak into the ground. Sandy, stony or very shallow soils are not suited for terracing. They are expensive to construct and difficult to maintain.

8.1 Factors that Determine Suitability of Soil:

8.1.1 Permeability and erodibility of a soil will vary and will influence the cross-sectional dimensions, grade and spacing from one terrace to another.

8.1.2 Soil Structure: This is important for determining the season of the year in which the terrace should be constructed, the ease with which it is constructed, and the time, power and type of equipment needed for construction. For example, if soil that is high in clay content, cloddy to massive in structure and is worked while wet, it will compact under heavy equipment and destroy permeability.

8.1.3 Texture: Bonding levels between individual particles of soils, determine suitability of that soil for terracing. For example sandy soil terraces will not last long.

8.1.4 Depth/ Hardpan: In shallow soils or where a hardpan exists (underlying clay zone), water is absorbed only to a limited amount. This results in excess runoff and destruction of the terrace.

8.2 Economics: Terracing correctly is an expensive proposition. In order to be cost effective, some situations may warrant crop rotations, strip-cropping or contour tillage. These methods of erosion control and water conservation are much less expensive and may be the only measures that are either required or suited to the situation. In high rainfall areas with long slopes it may be economically necessary to install terraces.

8.3 Types of Terraces: Terraces may be classed as:

8.3.1 Absorption Type.

In low rainfall areas water conservation is of primary importance. A ridge is the best structure for increasing absorption over a wide area above the ridge.

8.3.2 Interception or Diversion Type.

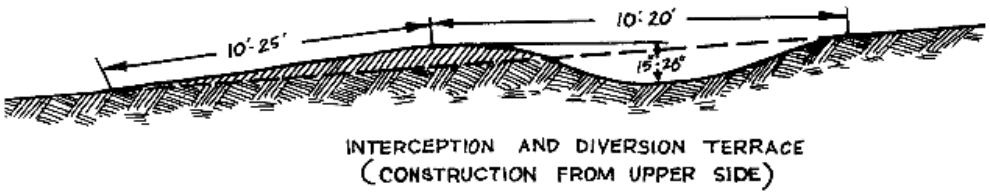
If water is in plentiful supply, then interception or diversion is desirable. Here water is intercepted in the terrace and diverted down a gentle gradient. Thus velocity of water flow is reduced. This in turn reduces erodibility. A channel that is somewhat below the original ground surface is best suited to intercepting and diverting runoff water.

8.4 Areas with moderate rainfall and favorable soil conditions may need a combination of both types. Terraces may also be classified according to method of construction:

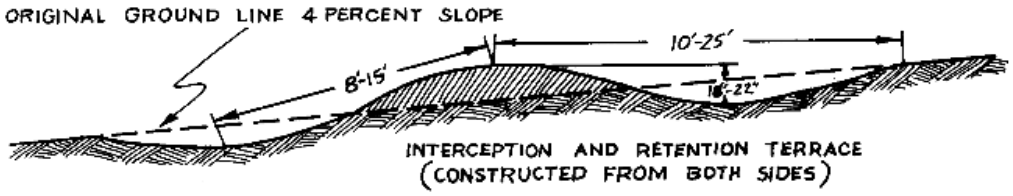
8.4.1 The Broad Channel Terrace conducts excess rainwater from fields at non-erosive velocities. This consists of a wide and relatively shallow channel of low gradient with gentle side slopes and ample water capacity. Excavated earth is used to heighten the lower side of the channel and to add water capacity. The ridge should blend with the surface slope in order not to interfere with equipment. The downside of the ridge should also conform to the slope to reduce danger of erosion.

8.4.2 A Ridge Terrace controls erosion indirectly by conserving water and permitting it to soak into the ground. The terrace is so constructed as to ensure maximum spread of water and avoid concentration in small ponds. Absorption rates and rainfall patterns are carefully studied while designing such terraces. This type of terrace is adapted to area with low rainfall.

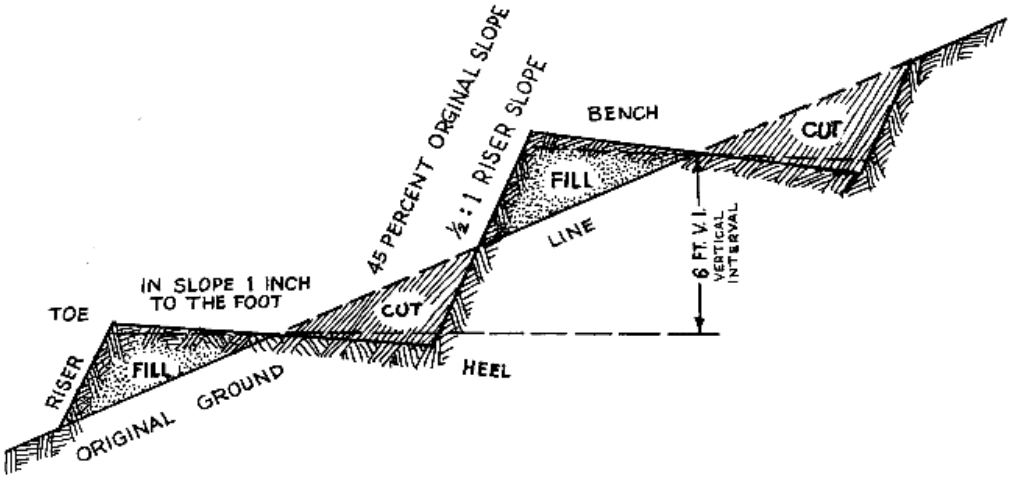
8.4.3 Bench Terraces are one of the oldest mechanical methods of erosion control. These transform land with 15 to 50 % slopes into a series of level steps running across the slope. Since topsoil is moved from the upper portion of the terrace, artificial fertilization, incorporation of organic matter and green manuring are used to regenerate the soils fertility. This type of terrace is in use in Abbottabad District, like most of the mountainous North. However, water conservation or diversion is not practiced.



INTERCEPTION AND DIVERSION TERRACE
(CONSTRUCTION FROM UPPER SIDE)



INTERCEPTION AND RETENTION TERRACE
(CONSTRUCTED FROM BOTH SIDES)



Cross-section of a broad channel terrace (top), a ridge terrace (middle), and a bench terrace (below).

Figure 6: Types of Terraces.

8.5 Cultural Practices on Terraces:

Use of equipment is an important factor while designing terraces. Closely spaced or steep slopes will not allow the use of equipment. Cropping practices are also a factor for design. Certain crops protect soils from erosion. The degree to which a crop protects soil during adverse seasons and the stage of growth during seasons of intense rainfall is of particular importance. Proper management and maintenance of the terrace will determine success. Faulty tillage can lead to

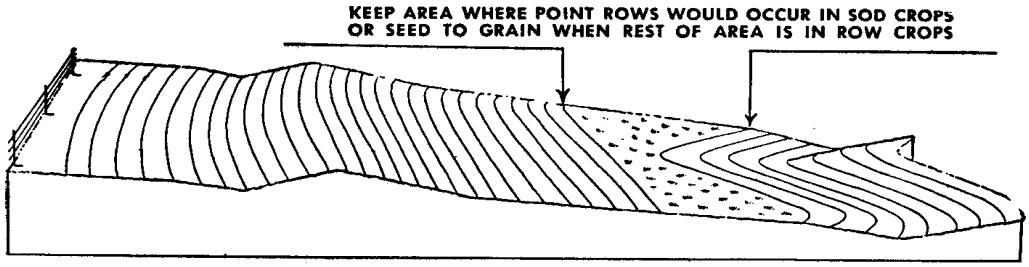
ruin. It is desirable to till the land on the contour. To plant crops in rows that are parallel to the terrace. Thereby creating small ridges that aid in slowing down the flow of water. Terracing can be combined with strip cropping to control erosion and water movement. Certain features of these two control systems must be kept in mind while combining them, these are:

8.5.1 Make strips as uniform as possible in order to practice crop rotation.

8.5.2 Ensure that at least one row of a strip falls between adjacent terraces, ridge or broad channel. This ensures that a portion of each terrace interval is protected by close growing crops.

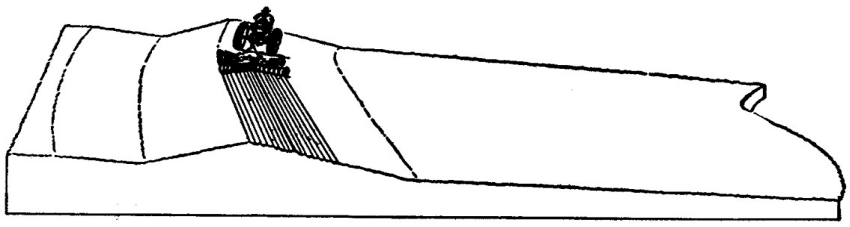
8.5.3 Eliminate areas where rows come to a point, as far as possible, by including irregular areas in the strip.

8.5.4 Use as few strips as possible in order to provide effective erosion control.



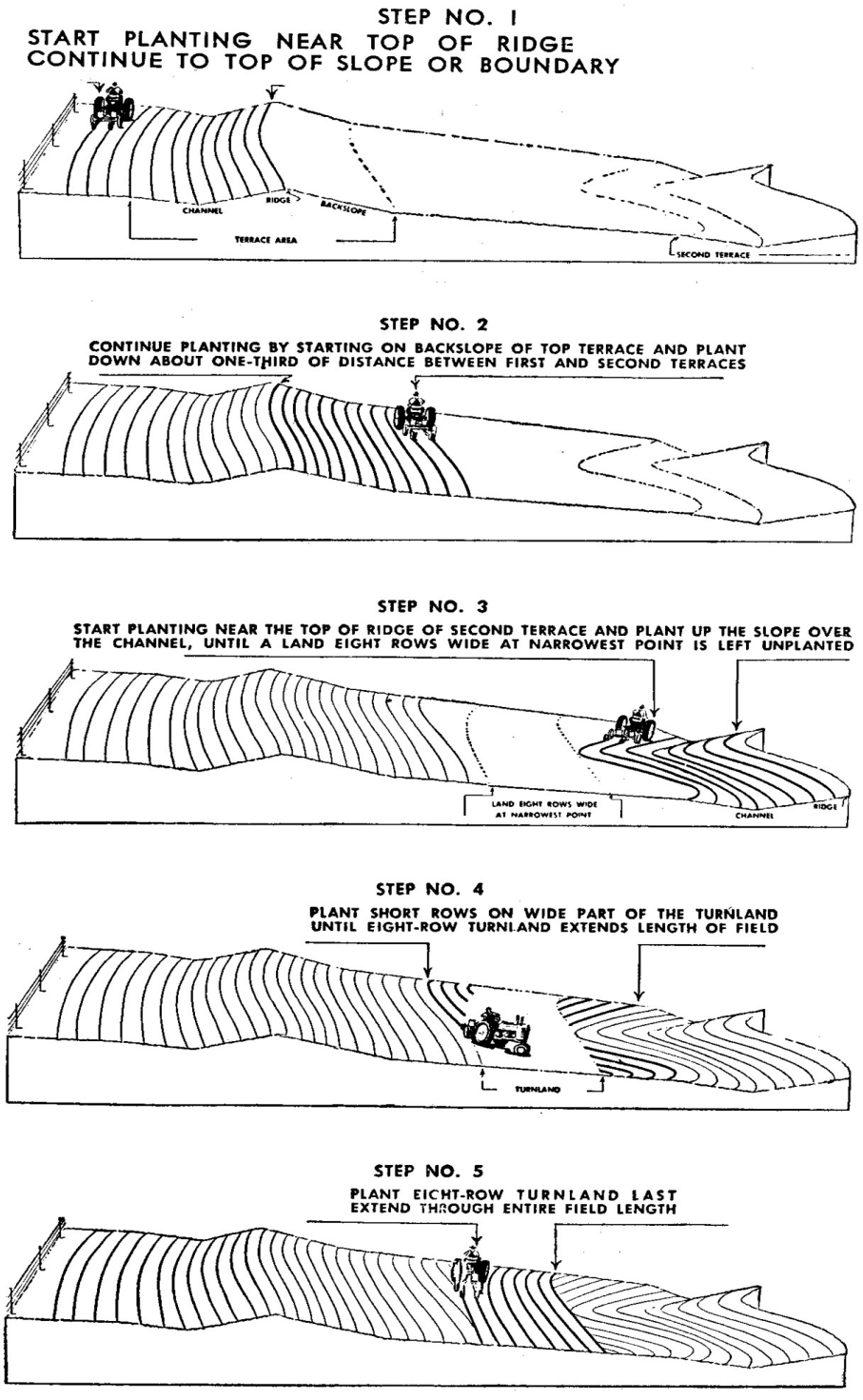
The uneven areas between terraces may be left in close growing crops.

Figure 7: Planting Between Terraces.



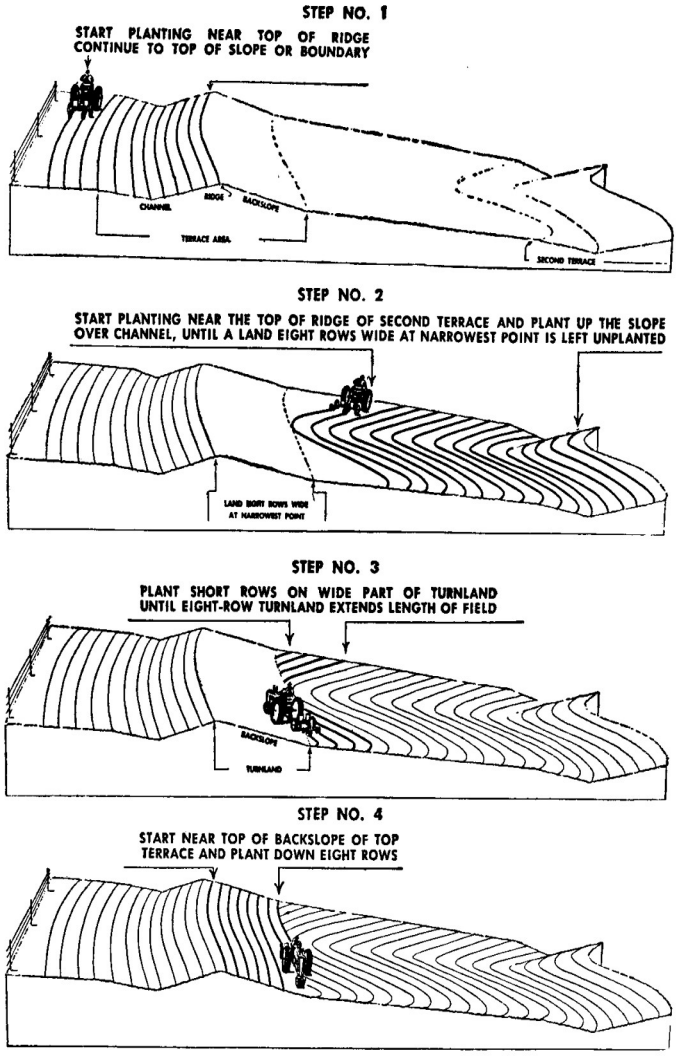
Operate disks, cultivators, drills, spring-tooth harrows and other earth cutting tools on the contour, using terraces as guide lines.

Figure 8: Operating Machinery on the Contour.

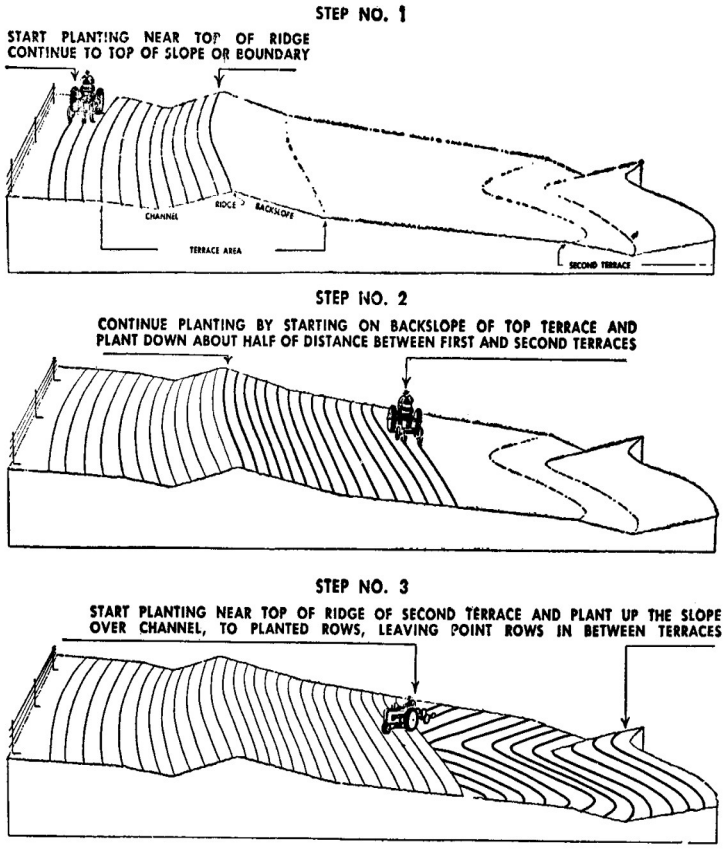

STEP NO. 1
START PLANTING NEAR TOP OF RIDGE
CONTINUE TO TOP OF SLOPE OR BOUNDARY
CHANNEL
RIDGE
BACKSLOPE
TERRACE AREA
SECOND TERRACE
STEP NO. 2
CONTINUE PLANTING BY STARTING ON BACKSLOPE OF TOP TERRACE AND PLANT DOWN ABOUT ONE-THIRD OF DISTANCE BETWEEN FIRST AND SECOND TERRACES
STEP NO. 3
START PLANTING NEAR THE TOP OF RIDGE OF SECOND TERRACE AND PLANT UP THE SLOPE OVER THE CHANNEL, UNTIL A LAND EIGHT ROWS WIDE AT NARROWEST POINT IS LEFT UNPLANTED
LAND EIGHT ROWS WIDE AT NARROWEST POINT
CHANNEL
RIDGE
STEP NO. 4
PLANT SHORT ROWS ON WIDE PART OF THE TURNLAND UNTIL EIGHT-ROW TURNLAND EXTENDS LENGTH OF FIELD
TURNLAND
STEP NO. 5
PLANT EIGHT-ROW TURNLAND LAST EXTEND THROUGH ENTIRE FIELD LENGTH

Planting row crops on terraced land: Method A.

Figure 9: Planting on the Terrace, Method A.


STEP NO. 1
START PLANTING NEAR TOP OF RIDGE
CONTINUE TO TOP OF SLOPE OR BOUNDARY
CHANNEL
RIDGE
BACKSLOPE
TERRACE AREA
SECOND TERRACE
STEP NO. 2
START PLANTING NEAR THE TOP OF RIDGE OF SECOND TERRACE AND PLANT UP THE SLOPE
OVER CHANNEL, UNTIL A LAND EIGHT ROWS WIDE AT NARROWEST POINT IS LEFT UNPLANTED
LAND EIGHT ROWS WIDE
AT NARROWEST POINT
STEP NO. 3
PLANT SHORT ROWS ON WIDE PART OF TURNLAND
UNTIL EIGHT-ROW TURNLAND EXTENDS LENGTH OF FIELD
BACKSLOPE
TURNLAND
STEP NO. 4
START NEAR TOP OF BACKSLOPE OF TOP
TERRACE AND PLANT DOWN EIGHT ROWS

Planting crops on terraced land: Method B.


STEP NO. 1
START PLANTING NEAR TOP OF RIDGE
CONTINUE TO TOP OF SLOPE OR BOUNDARY
CHANNEL
RIDGE
BACKSLOPE
TERRACE AREA
SECOND TERRACE
STEP NO. 2
CONTINUE PLANTING BY STARTING ON BACKSLOPE OF TOP TERRACE AND
PLANT DOWN ABOUT HALF OF DISTANCE BETWEEN FIRST AND SECOND TERRACES
STEP NO. 3
START PLANTING NEAR TOP OF RIDGE OF SECOND TERRACE AND PLANT UP THE SLOPE
OVER CHANNEL, TO PLANTED ROWS, LEAVING POINT ROWS IN BETWEEN TERRACES

Planting crops on terraced land: Method C.

Figure 10: Planting on the Terrace, Method B.

8.6 Terrace Construction: It is important to include all erosion control factors in a terrace design. Drainage waterways, slope changes, roads, boundaries, and large gullies must be considered.

8.6.1 Hydraulics: Hydraulics takes into consideration the action of the movement of water. Rainfall and consequent movement down the slope is taken into account. Terraces are designed to slow down this flow. Excessive rainfall and subsequent rapid flows will erode the soil, especially in the case of plowed land. At velocities of 2 or more feet per second, water will loosen and move soil from unprotected land. As water moves downhill it gathers velocity. Terraces intercept run-off before velocities reach harmful rates. Slope of the land, velocity of run-off and amount of rainfall are thus the first factors taken into account while designing terraces.

8.6.2 Velocities in Terrace Channel: A terrace channel, an essential part of the terrace and most often missing in our terraces, must be capable of containing maximum expected run-off. Its width should be broad enough to carry water at non-erosive velocities. Flow of water, in a terrace channel, increases as slope increases, as depth of water increases and as roughness of a channel decreases. Broad, flat channels allow greater volumes of water to flow without increasing velocity. It is important to maintain a uniform cross section along the channel. In order to be able to handle increasing volumes of water, gradients are increased along successive portions of the channel. The upper portions of the terrace should contain flatter grades in order to retard the flow of water. This is necessary in order to disallow water from piling up in the lower reaches of the terrace.

8.6.3 Manning the Terrace System: Sites for outlet or disposal channels have to be selected before a terrace can be constructed. Broad, natural waterways with natural vegetation are the most preferable feature. Outlets are usually planned and constructed several seasons before a terrace is constructed. This allows plenty of time for their stabilization. The best outlet channel is a wide flat or parabolic structure. Gradients should be 6 % or less. Care should be taken in selecting vegetation cover in the outlet. Dense and deeply rooted grasses can stand velocities up to 5 to 7 feet per second.

8.7 Location: The location of a terrace must cater for:

8.7.1 Control of surface water.

8.7.2 Operation of farm equipment.

8.7.3 Requirement of minimum maintenance.

8.8 Terrace Specifications: Factors to be considered while developing terrace specifications:

8.8.1 Slope.

8.8.2 Rainfall.

8.8.3 Run-off Rates.

8.8.4 Soil Characteristics.

8.8.5 Tillage Operations.

8.8.6 Vegetative Cover.

8.8.7 Cultivation Practices.

8.9 Generalizations:

8.9.1 Limiting Land Slopes: Slopes greater than 12 % usually limit the possibility of building a terrace.

8.9.2 Spacing: The spacing of terraces varies inversely with the steepness of the slope. This means that as a slope becomes steeper, the distance between terraces decreases. A basic spacing formula can be used:

VI = S/3 + 2

VI = Vertical Interval.
S = Slope in percent.

Vertical interval is the vertical distance from the bottom of one terrace to the bottom of the terrace immediately below.

8.9.3 Grades: Steep grades result in high velocities of run-off. Variable grade control is better than uniform grade. The maximum advisable grade is 4 inches per 100 feet of length.

8.9.4 Length of Terrace. The maximum length of a terrace that carries water in one direction is 1,600 feet. Shorter terraces are more desirable for controlling run-off.

8.9.5 Terrace Width: This depends upon the following considerations:

(a) Terrace must have ample channel capacity to handle water flowing into it.
(b) Channel and ridge side slopes must be able to permit the use of farm machinery without breaking down the sides of the terrace.
(c) Must be economically practical.

8.10 Terrace Construction.

8.10.1 Locate all ridges and depressions

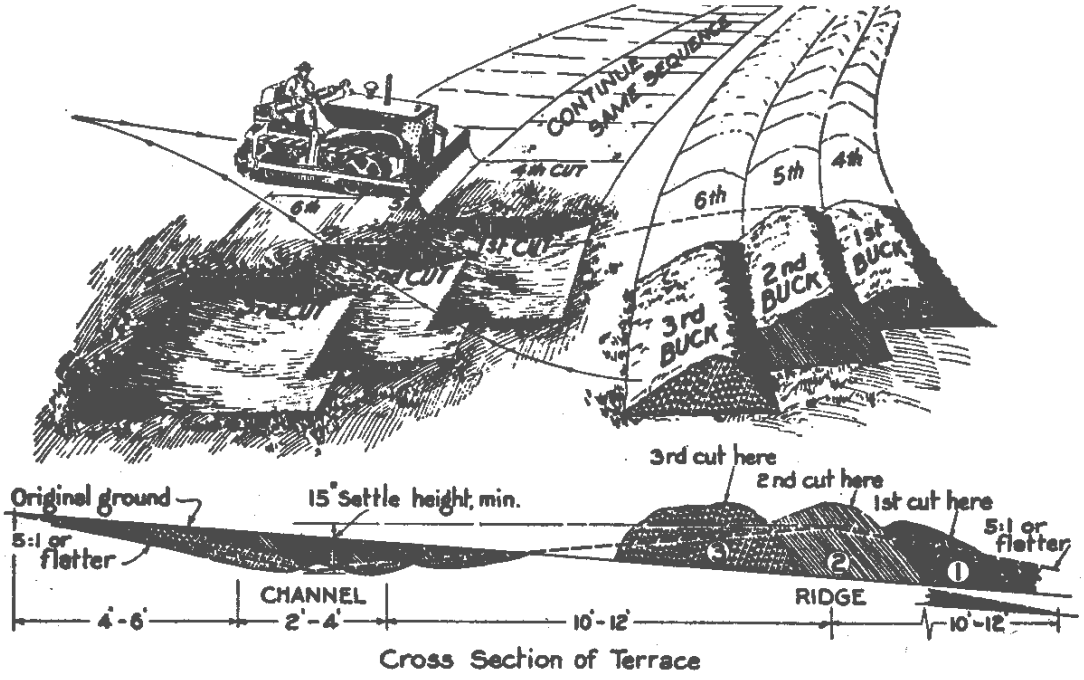
8.10.2 Grade the intended terrace to drain from the ridge to the natural drainage way if possible.

8.10.3 Stake the upper terrace, using the drainage divide as a starting point from which to measure the vertical interval.

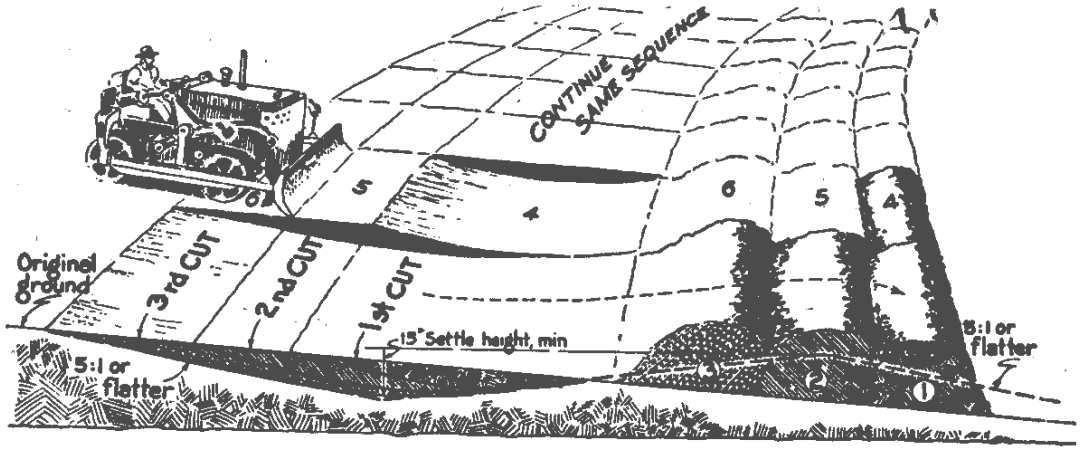
8.10.4 Each succeeding terrace is staked in turn. The outlet end of a terrace is a convenient point to start staking. Stakes are normally 50 feet apart on the centerline of the terrace ridge. When the terrace goes over a ridge or through a depression, stakes are normally set 25 feet apart.

8.10.5 After stakes are set, it may be necessary to realign them to eliminate sharp curves and make for easier construction and eventual cultivation.

8.11 Terraces can be constructed by any type of equipment that will move soil and can gain access to the area. Terraces require attention and maintenance every year to keep them in their original condition. It must be borne in mind that there is an intimate and complex relationship between all Soil Conservation measures like Contour Farming, Strip-Cropping, Grass waterways, Use of fertilizers and Terraces.

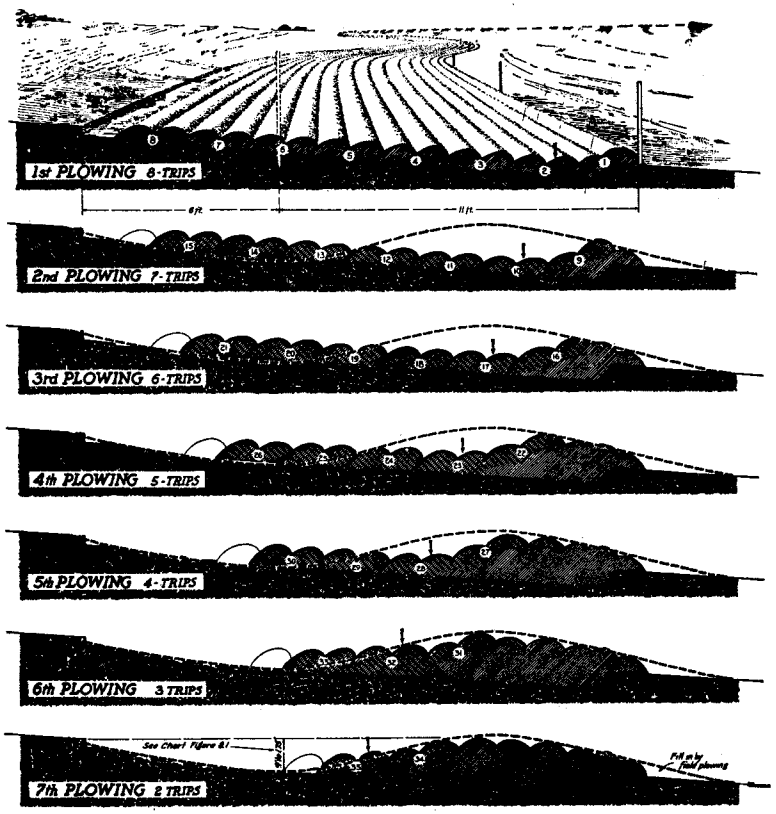


Using a bulldozer to build terraces: Staggered cut method.

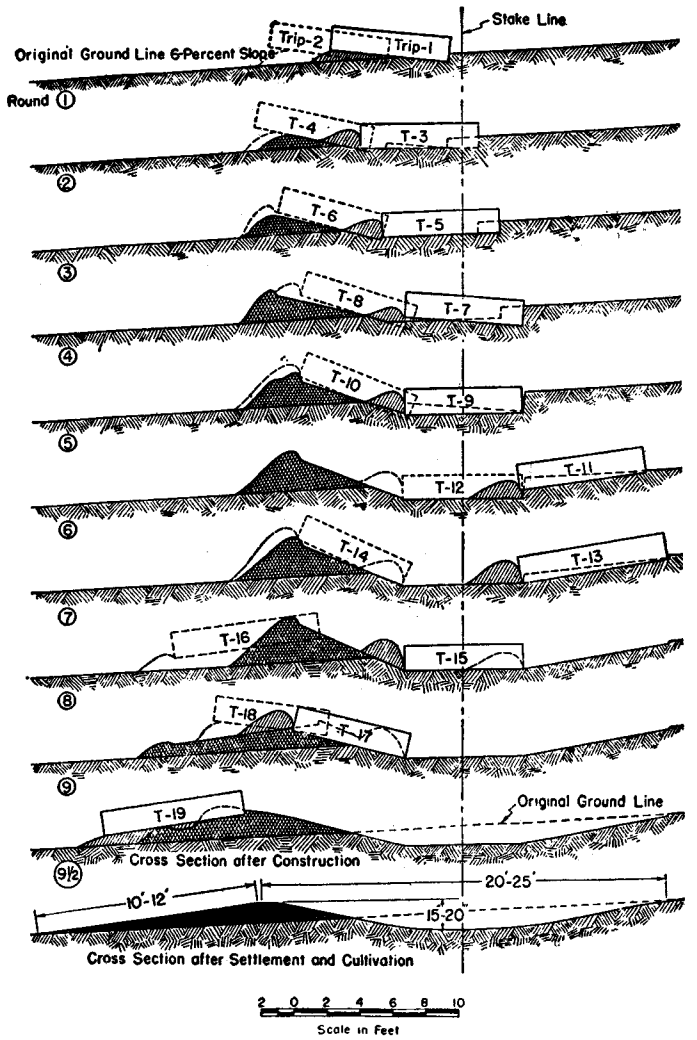


Using a bulldozer to build terraces: Straight cut method.

Figure 11: Using a Bulldozer to Build Terraces.



Sequence for building terraces using a two-way plow.



Steps in the construction of a broad channel terrace.

Figure 12: Using a Tractor to Build Terraces.

9. **GULLY CONTROL:** In areas of heavy rainfall and steep slopes, gullying is a serious problem. Where natural vegetation has been allowed to flourish, the cover provided to the soil allows the force of raindrops to be decreased. Run-off is also slowed down; this results in water being allowed to sink into the ground instead of accelerating erosion. This charges the aquifers and maintains topsoil cover. Soil takes millions of years to build. It can be washed away in a matter of days. Topsoil is a precious asset and determines the fertility of the land. Naturally charged aquifers are another great asset and our very survival depends upon them. Thus it is important to maintain vegetative cover and also to plug any gullies that have been created. Gullies are usually formed in the natural waterways and drainage lines of the physical relief. It is possible to stabilize gullies or improve them to act as reservoirs or water disposal systems. Gullies are considered by size, a small gully is 8 feet or less in depth. Medium gullies are from 8 to 15 feet deep and large gullies are those above 15 feet in depth. Drainage area is considered as that area which provides the run-off that enters the gully. Gullies with less than 50 acres drainage area are considered as small drainage areas. Drainage from 50 to 150 acres is considered as medium and drainage areas above 150 acres are considered as large drainage areas. Obviously the most cost-effective gullies to control are small gullies with small drainage areas.

9.1 Improvement Measures: These consist of:

9.1.1 Fencing: Livestock, that is allowed to graze openly, have a detrimental effect upon emerging gullies. Fencing readily protects small gullies with small drainage areas. Land that is badly gullied and cannot be restored to cropland is usually treated in this manner. Fences should enclose the area completely and be set back enough to allow natural re-vegetation to take root and protect the gullies from further deterioration. In case natural re-vegetation is too slow, or difficult to establish, planting a mixture of grasses, shrubs and trees can help the process.

9.1.1 Natural Vegetation: Regular erosive flow of water often washes away seed and young plants. A good mulch of straw, twigs or leaves will control this action. The steepness of the sides of the gully will also determine the degree of natural re-vegetation. The steeper the slope the more difficult is it for plants to be established. Slopes of 1 to 1 grades are about the limit for natural vegetation to take root. Working the slopes can help this along.

9.1.3 Artificial Re-vegetation: This depends upon the eventual use to which the gullied land is to be put to. In case a natural drainage way is desired, grass is the best cover and provides more erosion control than woody plants. Thus hay can be made from the area. In case drainage is not so important the area can be planted with a desired species of trees for Farm Forestry. Grass plantations can be made by any of the following methods:

(a) Seeding. This is only possible with fertile soil and seed bed preparation.

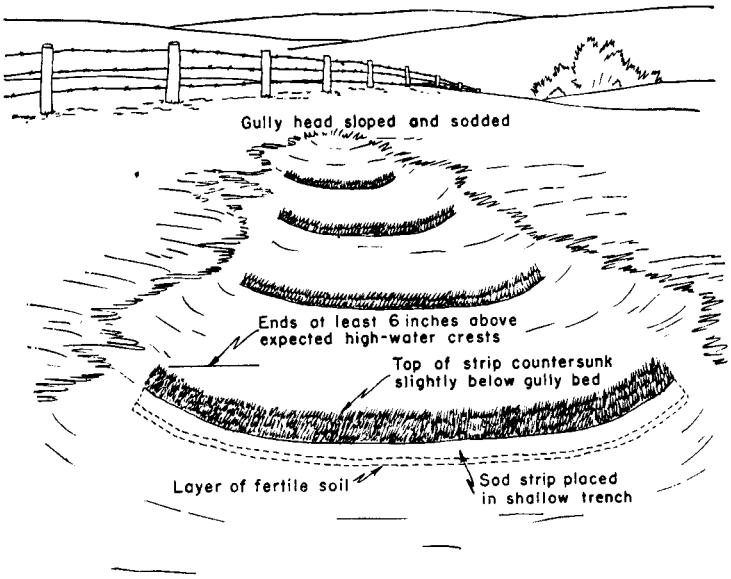
(b) Solid Sodding. Sod strips of usually 1 foot width and 8 to 10 feet length are cut and placed as continuos cover. Sod can be stapled down or covered with wire mesh to allow it to establish before facing heavy run-off.

(c) Broadcast Sodding. An inexpensive alternate, that saves time and labor, is to disk up existing sod and disk into the bed of the gully. This method can only be used with grasses that propagate themselves through the roots. The fertile soil and roots can establish themselves in the gully. This method takes longer for the gully to be stabilized.

(d) Strip and Spot Sodding. Here trenches are made in the same dimensions as the strips that are to be transplanted. This method is used along with seeding in the

intervals between strips. Spot sodding is the transplanting of small clumps of grass, with intervals, over the area to be planted.

(e) Sod Checks. This method stabilizes gully channels until natural re-vegetation takes hold. The Sod Strip is suited to small gullies with small to medium drainage areas. Sod Strips are laid across the gully channel either flush with or slightly below grade. Strips should be a minimum of 12 inches wide and should run up at least 6 inches above the expected water line on each side of the gully. The spacing of the strips depends upon the spreading nature of the sod, the drainage area and the grade of the gully. Spacings of 5 to 7 feet are common. Contour Sod Strips are used where gully sides are steep and it is difficult for natural vegetation to establish.


Gully head sloped and sodded
Ends at least 6 inches above expected high-water crests
Top of strip countersunk slightly below gully bed
Layer of fertile soil
Sod strip placed in shallow trench

Sod-strips are used to control erosion in a small gully. This method cannot be used in gullies with steep grades.

Figure 13: Sod-Strip Gully Stabilization.

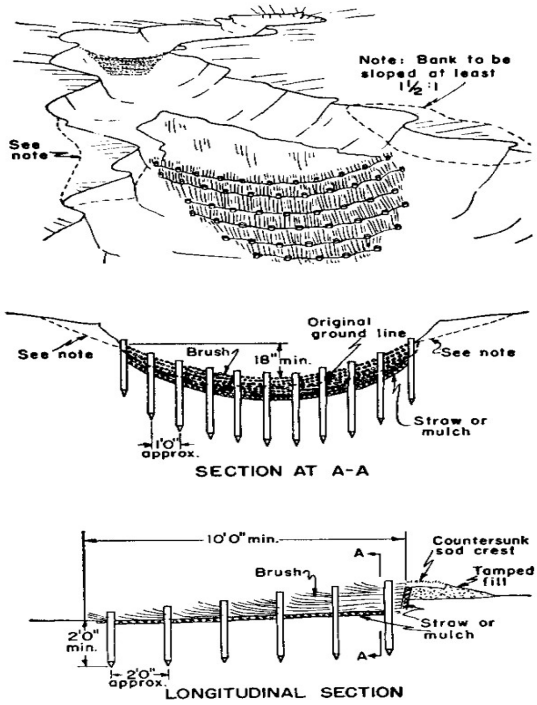
(f) Trees and Shrubs: In case it is desirable to replant the gully with trees and shrubs, only those species should be selected that are usually growing in the area. This is due to the fact that they are acclimatized and better suited to adapt to harsh growing conditions of gullies. Solid planting of one species is best avoided. Disease incidence and insect attack can lead to failure of the entire stand. Several species have the advantage of less competition and can also contribute to disease control by lack of similar environment to particular types of pests. Mixed plantations also encourage wildlife. Spacing of plants depends upon species of planting and condition of the gully. However, 6 feet either way is best suited for erosion control. Shrubs can be planted at 3 and 4 feet either way. Planting is avoided on steep slopes or steps cut into the slope. It is also advised that planting

on overhangs and too close to edges should be avoided. Small or medium size gullies can also be stabilized by the use of shrubs and stakes. Here shrubs are planted across the flow of the gully channel at 4 to 5 inch intervals and are protected by stakes. Stakes are placed 1 foot down the channel from the shrubs in order to make use of accumulated silt for the shrubs. Shrub checks reduce velocities of flow and induce silting. They can only be used in gullies with mild grades.

9.2 Structures: Structures are used where protection has to be provided and vegetation cannot do the job adequately. These structures are either temporary or permanent. In case run-off is limited, the structures can be temporary until natural vegetation can take root. Temporary structures can consist of brush, poles, wire and loose rocks. In the case of heavy run-offs, permanent structures are used. These should be made of durable material like masonry, concrete, metal or earth. Where ever possible, it is advisable to supplement structures by vegetation.

9.2.1 Temporary Structures: These are used to collect and hold soil at the bottom of the gully till vegetation is established. They can also be used to check erosion in the gully head or in the channel of the gully. In cases of negligible run-off, compacted stones or brush on the bottom of the channel is usually sufficient. Several low check dams are more effective than one large structure. An average height of 1 foot is usually the limit. Once these check dams silt up, vegetation can protect low over-falls more easily than high ones. Spacing can be regular or siting at critical points to protect vegetation can be used. The latter method results in fewer dams and less cost/ effort. This type of structure is used in gullies with small drainage areas. Soil collected is less in quantity but is sufficient to allow the establishment of vegetation. The structures should be constructed far enough into the bottom of the gully to prevent washouts underneath or around the edges of the dam. Sufficient capacity, to channel away run-off, should be included. An apron, that prevents the undermining action of run-off, should also be provided.

(a) Brush Dams: This type of dam is used where soil conditions permit the driving of anchoring stakes. The type of brush available, the size of the gully and its physical condition will determine the type of brush dam that is to be constructed. It is important to remember that the center of the dam should be lower than its sides in order to allow the water to flow over rather than towards the sides of the dam.

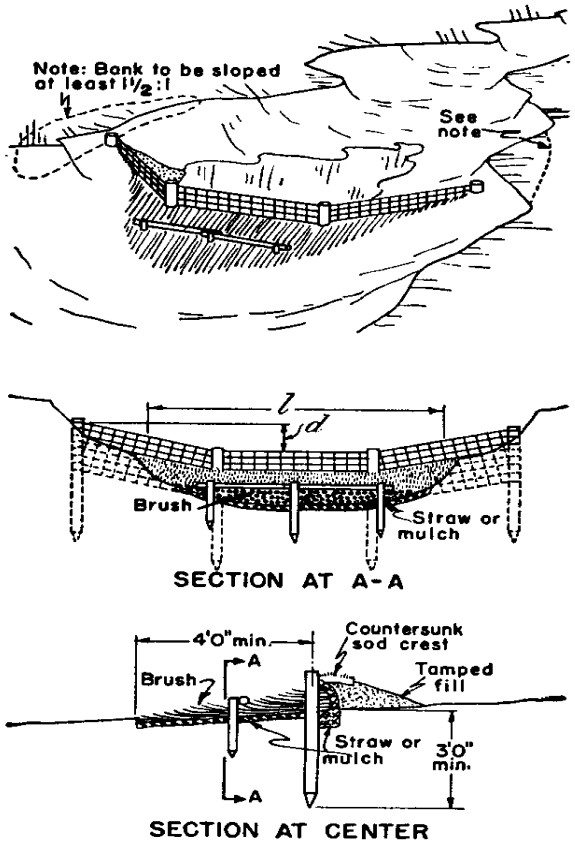


A brush dam in common use.

Figure 14: Brush Dam.

(b) Woven-Wire Dams. Gullies with moderate slopes and small drainage areas can benefit from this type of structure. It is widely used, due to ease of construction and adaptability to different types of gullies. They are commonly built in somewhat crescent or half-moon shape. The open end is, of course, directed up-stream. This design allows a longer spillway and protects the sides of the dam. Curvature is not fixed but is generally one sixth of the width of the gully. For example in a gully that is 24 feet wide, the spillway of the dam is 4 feet downstream of the abutments. The central portion of the intended site and consequently the center of the spillway are established. A stake is driven in to 2 to 3 feet depth. Similar stakes are driven in at 4 feet intervals on both sides along the intended curve. A trench that is 6 inches deep and 6 inches wide is dug upstream of the stakes. A heavy gage, woven wire net is placed against the stakes. The lower part of the net is set in the ditch so that 10 to 12 inches project above the surface along the spillway interval. The wire is securely stapled to the posts. The top of the wire should be kept level along the central interval in order to ensure better spreading of water as it passes over the structure. In case rocks are available they can be used for the apron. If not, brush or sod will suffice. If brush

is used the Butt ends are pulled through the wire mesh to be held by the fill. The apron should be at least 4 feet long and extend 2 feet on each side of the posts that form the level portion of the spillway. A tie pole anchored with stakes can be used to compress the brush. The apron should be counter sunk and shorter brush should be used near the upper end, to produce a shingle effect. A layer of fine mulch can be laid under the brush to provide a better bonding with the surface. It is desirable to promote rapid filling and sealing of the structure. To obtain this, straw, fine brush or similar material is packed against the wire on the upstream side to the height of the spillway. This is then backed with well-tamped earth of at least 2 to 1 slope. The spillway crest can be sodded to prevent channeling along the lip. The minimum value of "d" in the illustration below should be 18 inches.

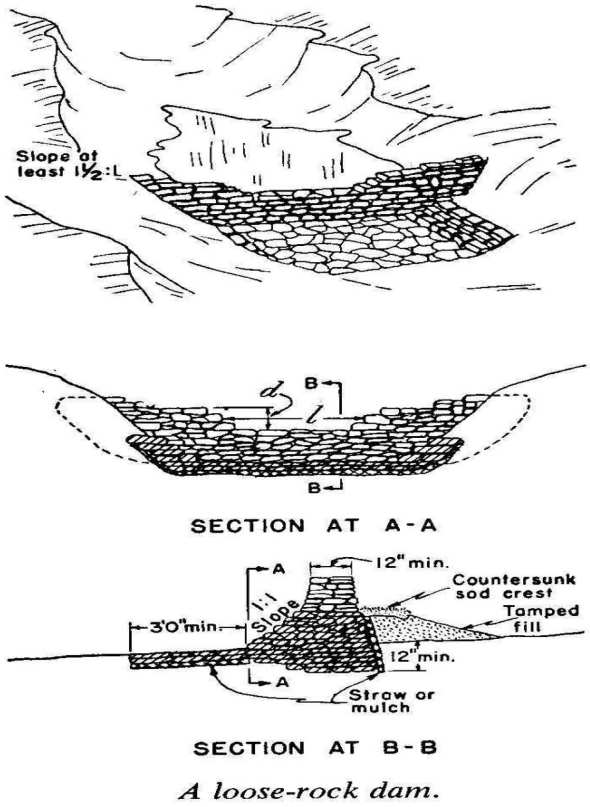


A woven-wire dam.

Figure 15: Woven Wire Dam.

(c) Loose Rock Dams. These are desirable in accordance to availability and ease of transportation. Gullies with moderate slopes and small to medium drainage areas are best suited for this type of structure. If flat stones are used they can be keyed together to provide for a very durable structure. In case rounded or irregular stones are used it is advisable to hold them in a woven wire net. A trench to the

depth of 1 foot is made across the gully at the proposed site. This is the base for setting the stones. The rocks are laid in rows across the gully and overlapped to produce the shingle effect. Once again the center of the dam is kept lower than the sides. Several large and flat stones are counter sunk below the spillway to serve as the apron. They should extend to about 3 feet downstream of the base of the dam.



A loose-rock dam.

Figure 16: Loose Rock Dam.

(d) Plank or Slab dams. This type of dam can be used in gullies with larger drainage area than those where woven-wire or brush dams can be used. This type of dam is constructed with planks of wood or with slabs of concrete. The latter is preferable, to conserve on wood and ensure durability. If the material can be readily transported this type of dam is quickest in construction. Pre formed RCC slabs can be readily used to construct the dam in a matter of hours. This dam also uses the conventional aprons and trench base.

9.2.2 Permanent Structures: These are built where permanent waterways are intended. Also large gullies with large drainage areas can support the construction of such structures. If water is to be stored on a permanent basis, this is the type of structure that is required. There also exists the possibility of generating Hydel Power from these Mini dams. Fish can be readily stocked and the water can also be used for irrigation and drinking supply purposes. In all cases it is more advisable and economically feasible to build multi-purpose mini dams where ever possible.

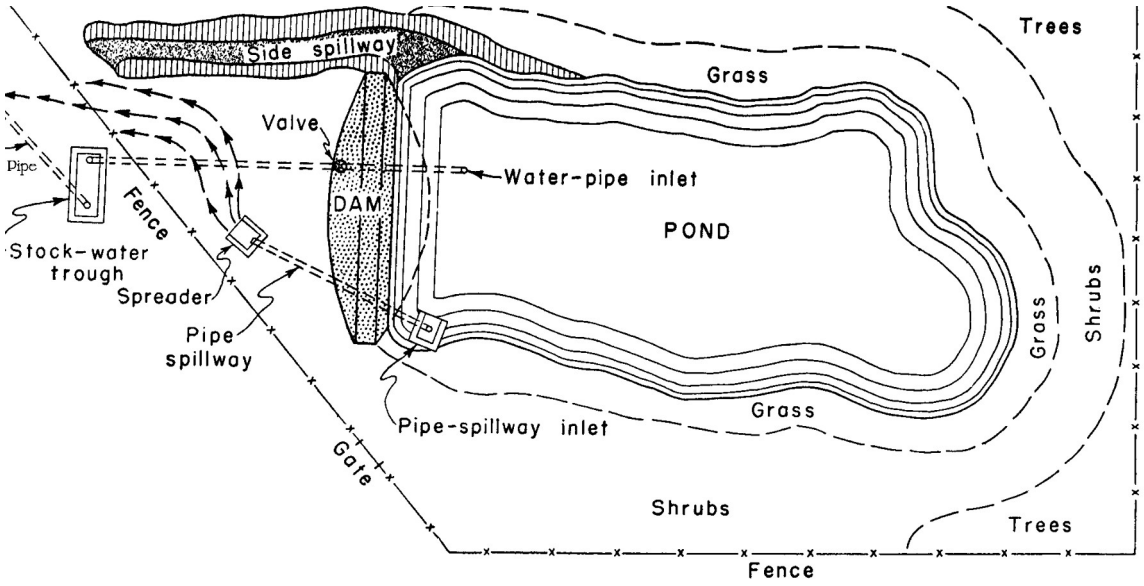


Illustration A: a typical farm pond layout.

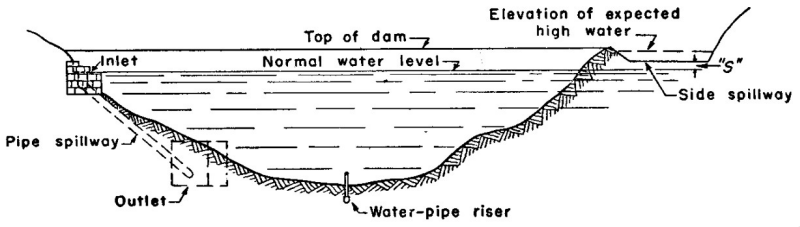


Illustration B: a profile through the axis of the dam, showing the elevations of the side spillway, pipe spillway and top of the dam.

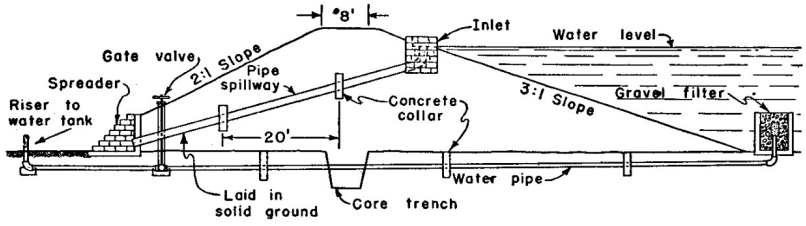


Illustration C: cross-section of the fill dam showing core trench, pipe spillway, water pipe, side slopes and top width.

Figure 17: Permanent Structure Earth Fill Dam.

The preceding illustrations are that of one kind of a Farm Pond that will suit many uses. By far the most important aspect, in this type of pond, is the spillway. If the spillway is too small there is every likelihood of failure of the pond. A combination of Pipe and Side spillway is the best. The Pipe spillway is for normal flow while the side spillway is for emergencies. Only extra run-off goes into the side spillway. Therefore it is possible to keep it in good sod cover, as it is dry most of the time. The bottom of the side spillway must be higher than the top of the pipe spillway. The distance, in height, between the two is shown, as "S" in illustration B. This distance will vary in accordance to the size of the watershed and that of the pond. It is possible to arrive at the right value of "S" by dividing the size of the watershed, in acres, with the size of the surface of the pond, also in acres. The result is then divided by 6. For example a watershed of 4.5 acres divided by a pond surface of 0.25 acres will yield 18 to be divided by 6. Thus a figure of 3 feet as the value of "S" or distance, in height, between the bottom of the side spillway and the top of the pipe spillway is established. This value of 3 feet is also the limit in height differential. In case this value is higher than 3 feet a different type of spillway will have to be designed by an experienced engineer. Long experience has determined the size of a spillway. By allowing the proper distance "S" between the pipe and side spillway the following sizes for spillways will suffice.

Table 10: Spillway Size.

Watershed Area In acres.	Diameter of Pipe Spillway in inches.	Bottom width of Side Spillway in feet
5 acres	4 inches	5 to 8 feet
10 acres	6 inches	8 to 10 feet
10 to 20 acres	8 inches	10 to 15 feet
20 to 30 acres	10 inches	15 to 20 feet

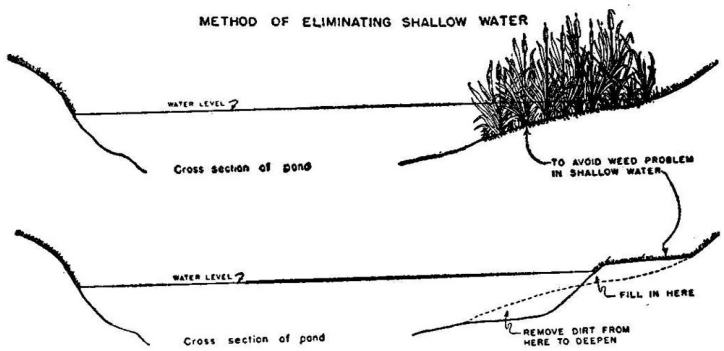
The bottom width of the side spillway is increased by 1 foot for each 2-acre increase in watershed area greater than 10 acres.

9.3 Weed Control: Weed growth in ponds can be stopped by some simple measures.

9.3.1 Eliminating shallow edges.

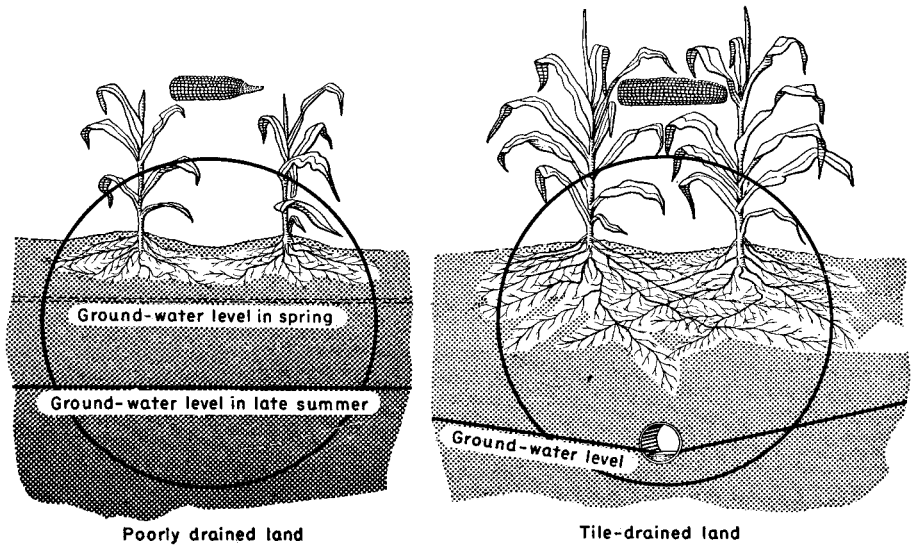
9.3.2 Fertilizing the pond to ensure a "Bloom" of algae. This results in cutting off light as the water is clouded and weeds cannot start growing. It also provides fish with their primary source of food.

Figure 18: Controlling Weeds.


METHOD OF ELIMINATING SHALLOW WATER
WATER LEVEL
Cross section of pond
TO AVOID WEED PROBLEM IN SHALLOW WATER
WATER LEVEL
FILL IN HERE
Cross section of pond
REMOVE DIRT FROM HERE TO DEEPEN

Pond edges should be deepened to control emergent plants and improve fishing.

10. **FARM DRAINAGE:** The central Rash Plain in the Abbottabad valley is poorly drained. In wet years this leads to extensive damage to crops and a reduction in yields. The drainage of wet croplands, that are fertile, is one of the most important of conservation farming measures. Production on these lands can be greatly increased with proper drainage. With drainage, more row crops can be grown on flat lands. This reduces the pressure on steep sloping land, which then can be used for close growing crops. Farm drainage must be carefully planned and implemented in order to ensure the desired results. Wet soils are cold due to the fact that it takes more heat to warm water rather than soil. Drained soils have their moisture content replaced with air. To grow well plants require warmth and air in their root zones. Friendly bacteria are also facilitated. Drained soils can be worked earlier in spring and seeds germinate faster. Plants also do not drown after rains. Crops that are planted on wet lands are often subject to burn out. In water saturated soils, plant roots spread on the surface in spring and early summer. Later, during summer drought the water table falls below the root zone and the crop is starved of water. Root penetration is deeper in well-drained soils and plants are thus drought resistant.



A poorly drained soil restricts the growth of plant roots.

Figure 19: Drainage Effect on Plants Roots.

10.1 Types of Drains:

Excess water can be drained by either:

a) Open Surface Drains.

b) Tile Drains.

Open surface drains occupy land and interfere with farm equipment. They readily choke up with weeds and require constant maintenance. Unless they are deep, they will drain only the surface and not the soil. Tight soils in humid areas however, require these types of drains. Tile drains neither waste land nor interfere with farm operations. They need little care when installed and drain the pores of the soil. Thus roots spread without

interference. With Ceramic Adobe Construction it is possible to manufacture tile drain material in abundance and at very little cost as a by-product[1]. Adequate drainage systems involve a number of farms or even a whole area. A land capability map as a basis for farm conservation will provide the necessary information for planning a drainage system. Successful farm drainage also includes plans for controlling erosion on the land, in ditches, on spoil banks and outlets. They include plans for farming the drained land in crop rotations that bring about good soil tilth or structure. Plans for keeping the drains working properly are also incorporated. The installation of a proper outlet for drainage water is of prime importance. Normally water is discharged by gravity into a natural watercourse. Community enterprises for such schemes are the beast course for planning, implementation and maintenance. In surface drainage, water is removed through open ditches. These field ditches open into larger collection ditches until they reach a natural or artificial watercourse. Field ditches should be laid out parallel and spaced 50 to 150 feet apart. As required by the soil, surface conditions and the crops to be grown. The area that is to be drained will depend upon the rate of flow of the water into the ditch, its size, its grade (slope or rate of fall of water surface) and its irregularity. This irregularity is effected by the roughness of the ditch section, debris and vegetation growing in the ditch. The amount and timing of rainfall, the slope of the land and the condition of the soil and plant cover, determine how quickly water runs into the drain. On level or gently sloping land, field and outlet ditches, to drain up to 600 acres, should be large enough to remove at least 2 inches of water from the area in 24 hours. Tables 11 and 12 show the areas that small V shaped and flat-bottomed ditches will drain, in grades up to 0.5 feet per 100 feet.

Tables 11 & 12: Computing Drainage Areas.

TABLE 1.—*Areas of level to gently rolling land that can be drained by V-shaped field ditches running full*

[Computed by Manning formula, $n=0.045$]

Depth of ditch (feet)	Top width of ditch	Side slopes	Excavation per 100 feet	Area drained by ditches with fall per 100 feet of—									
				0.02 foot	0.04 foot	0.06 foot	0.08 foot	0.1 foot	0.15 foot	0.2 foot	0.3 foot	0.4 foot	0.5 foot
	Feet		*Cubic yards*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1.0.....	6	3 to 1	11.1	10	14	17	20	22	28	32	39	45	50
	8	4 to 1	14.8	13	19	23	27	30	37	43	53	61	68
1.5.....	9	3 to 1	25.0	30	42	52	60	67	82	94	116	134	149
	12	4 to 1	33.3	40	57	70	81	90	110	127	156	180	202
2.0.....	12	3 to 1	44.5	64	91	111	128	143	176	203	249	287	321
	16	4 to 1	59.3	87	123	151	174	194	238	275	338	390	436

TABLE 2.—*Areas of level to gently rolling land that can be drained by small flat-bottom ditches with 2-to-1 side slopes, running full*

[Computed by Manning formula, $n=0.045$]

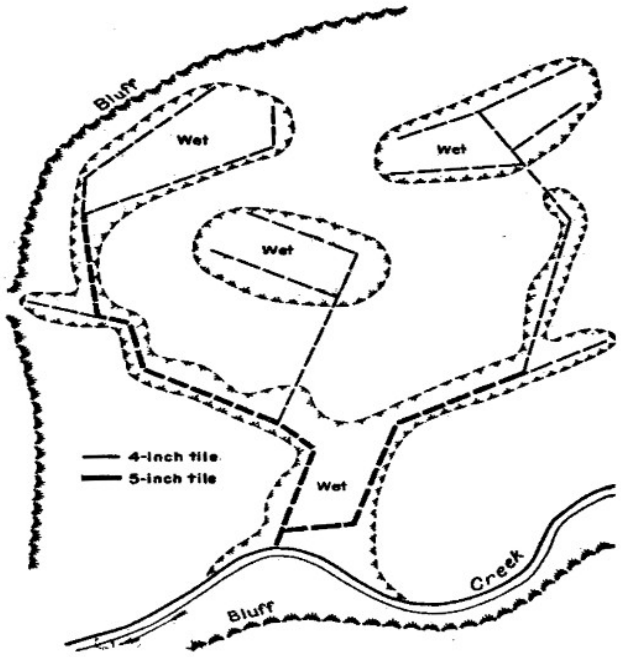
Depth of ditch (feet)	Bottom width of ditch	Top width of ditch	Excavation per 100 feet	Area drained by ditches with fall per 100 feet of—									
				0.02 foot	0.04 foot	0.06 foot	0.08 foot	0.1 foot	0.15 foot	0.2 foot	0.3 foot	0.4 foot	0.5 foot
	Feet	*Feet*	*Cubic yards*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1.5.....	4	10	38.9	57	81	100	115	129	157	182	223	258	288
	6	12	50.0	78	110	135	156	174	214	247	302	350	390
2.0.....	4	12	59.3	102	145	177	205	229	280	324	397	459	[1] 510
	6	14	74.1	135	191	234	270	301	369	426	525	604	[1] 700
2.5.....	4	14	83.3	162	230	282	325	363	445	515	630	[1] 800	[1] 970
	6	16	101.8	209	296	362	419	467	570	675	965	[1] 1,240	....

[1] Velocity is within range 2.6 to 3.0 feet per second.

[1] Extremely pertinent to Punjab, Sindh and where ever WaterLogging is a problem.

Flowing water will erode the soil. In many cases it is desirable to enforce low water velocity by constructing the ditch is sections having less fall than the natural slope and connecting these sections with drop spill ways. Drop spillways are recommended wherever the average velocity of the flow will exceed 4 feet per second in clay loams.

The tile drain is the best type of under drain. Water moves into the drain through gravity flow by entering through the joints between the tiles. Lay of the land and location of the outlet determines the placing of drains. In rolling land, these drains can be laid by lines of tiles in the natural watercourses. Extra branch lines are laid, as needed, in wide wet areas. This type of arrangement is called a Random System.

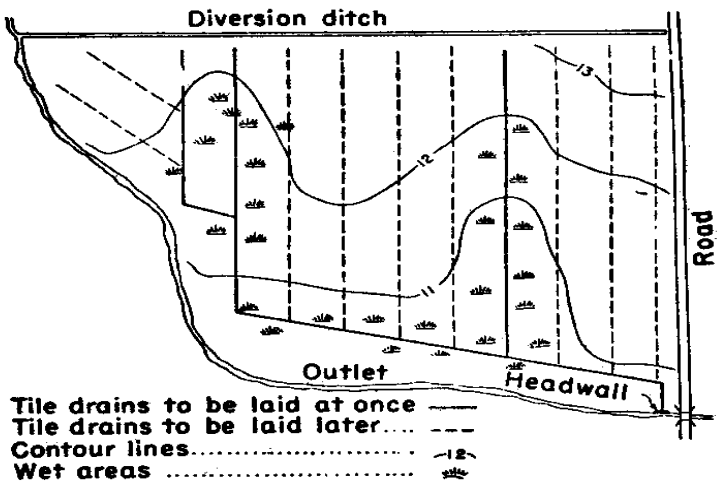


A random system for installing tile drains. Main drains are placed in natural waterways and branch lines are run to wet spots.

Figure 20: Random System.

If the land is too wet, the Complete System is a better option. The main drains follow the natural watercourses of surface flow. Laterals are laid in parallel lines, or groups of parallel lines, under the whole area. Laterals should be straight and run in the general direction of the greatest slope. They should be laid at such intervals and at such depths, as the land requires.

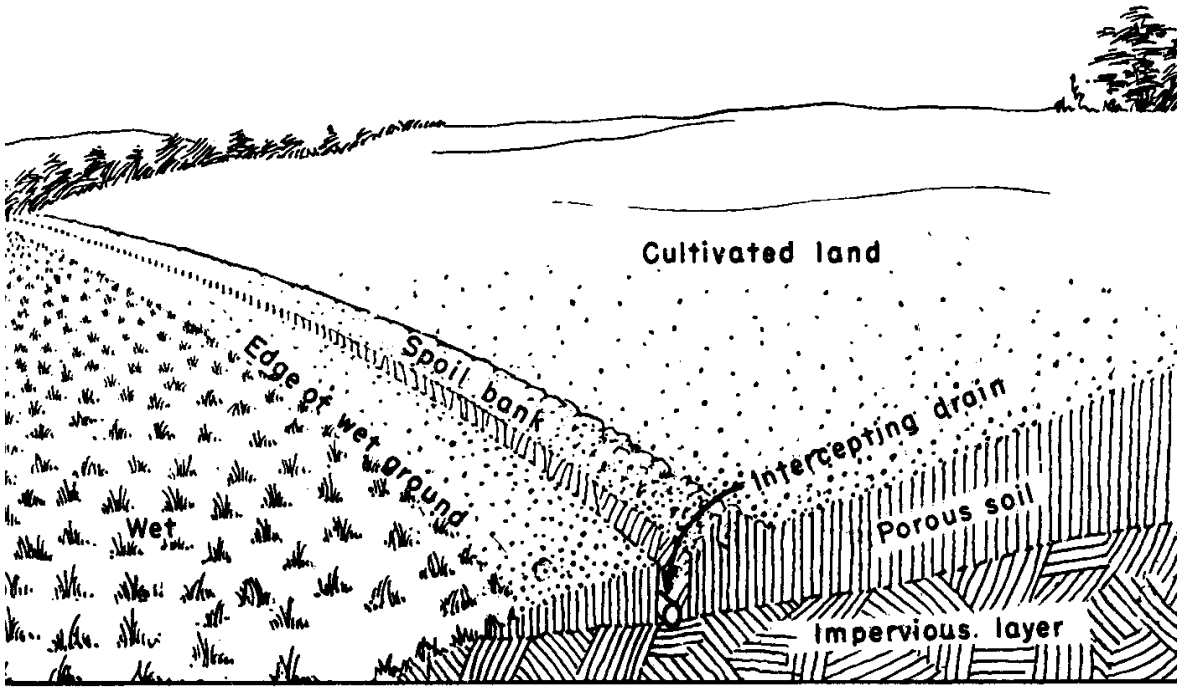
An impervious layer of soil, that stops the downward flow of water, usually causes wet areas at the bottom of valleys. This situation can be corrected by laying tile drains or combining them with Aquifer Recharging Wells. Here the tile drain's outlet leads to the inlet of the recharging well. Thus we achieve the added advantage of draining the soil as well as recharging of the aquifers. This combination is particularly suited to the Rash Plain.



Plan for a complete tile drainage system.

Figure 21: Complete System.

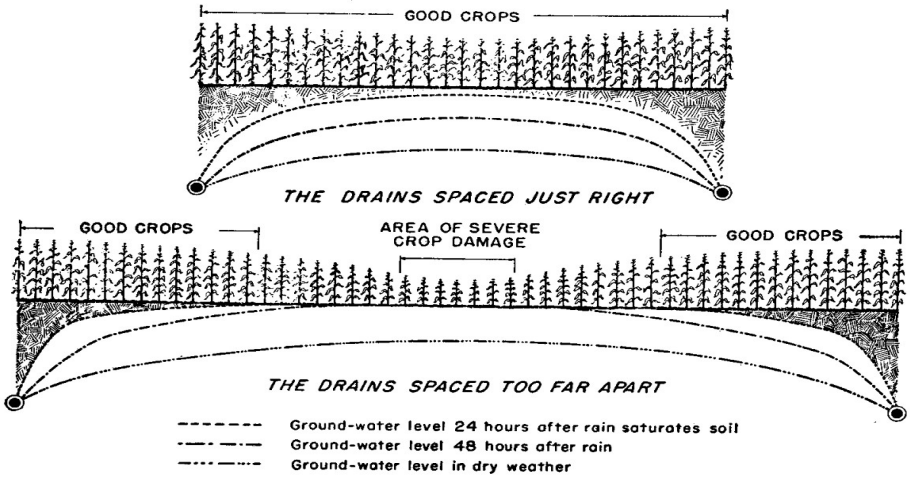
The drains should be laid deep enough to intercept water flowing along the top of the impervious layer. These drains should be spaced so as to lower the ground water enough for good plant growth within 24 hours after a rain.



Proper location for an intercepting drain.

Figure 22: Intercepting Drain.

The ground water surface is a curve that is lowest at the drains and ordinarily highest midway between them as shown in the following illustration.

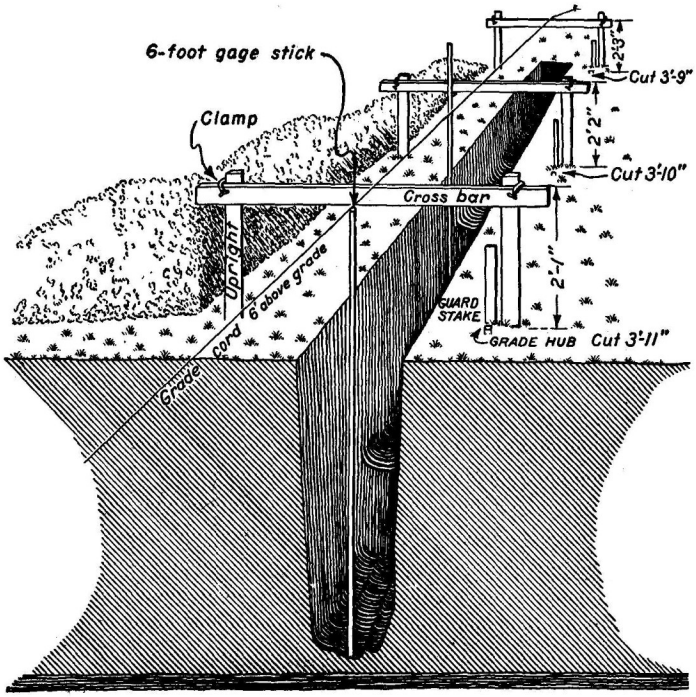

GOOD CROPS
THE DRAINS SPACED JUST RIGHT
GOOD CROPS
AREA OF SEVERE CROP DAMAGE
GOOD CROPS
THE DRAINS SPACED TOO FAR APART
Ground-water level 24 hours after rain saturates soil
Ground-water level 48 hours after rain
Ground-water level in dry weather

The spacing of tile drains will affect the ground water level and crop damage.

Figure 23: Ground water Level.

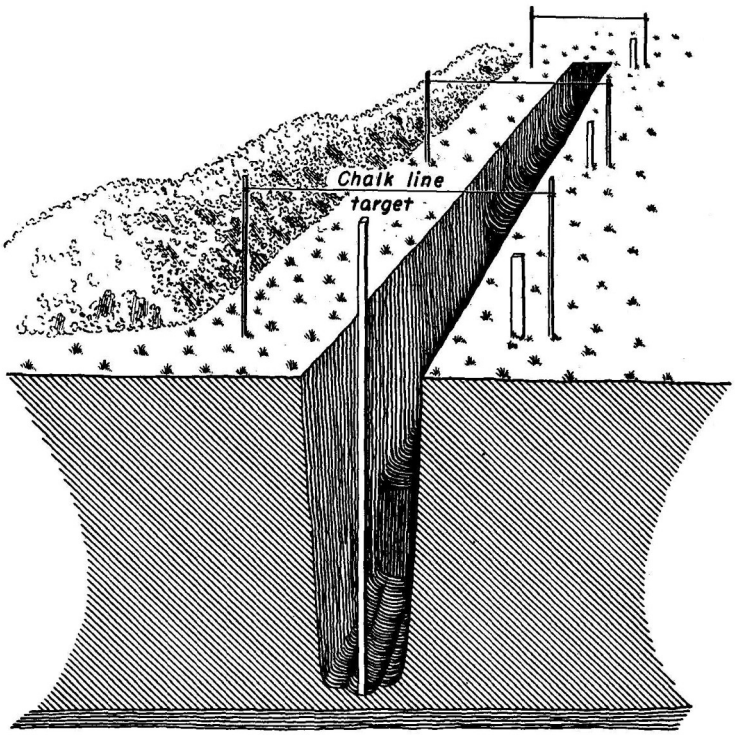
10.2 Construction: The soils structure and texture affect the rapidity with which drains lower the water. Clay soils, with a tendency to crack, greatly help the drains as water flows more readily through the cracks. In tight clay soils, water movement is very slow and drains must be placed closer to the surface and closer together. In clay and clay loams, as in the Rash Plain, drains should be placed 40 to 70 feet apart and 2.5 to 3 feet deep. No drain should be less than 2.5 feet deep. In other words, the bottom of the drain should be 2.5 feet below the surface. Large drains should be placed deeper. The drain should have a minimum of 2 feet soil cover. This is necessary in order to avoid breakage due to the passage of machinery. In silt loams, drains can be placed 60 to 100 feet apart and at depths of 3 to 4 feet. All tile drains should be deep enough to be free from frost damage.

Sizes of tiles, for mains and sub-mains, depend on many factors. Firstly, where surface drains carry off a large part of the water after storms, tile drains have to cater for only that part that seeps into the ground. A four-inch tile is the smallest that can be used in tile drains. A five-inch tile carries nearly twice as much water and is less susceptible to blockage by sediment. There are two methods of establishing grade for tile drains. These are Gage and Line and Target method as outlined below:



Gage-and-line method of establishing grade for a tile drain. A cut of 3 feet 11 inches is indicated at the hub in the first station. Subtracting this cut from the length of the gage stick (6 feet), the difference of 2 feet 1 inch is the height for setting the top of the cross-bar above the hub. The gage stick at the first station shows that the trench has been dug to the correct grade elevation at that point. The gage stick at the second station shows that more digging is required for the needed cut of 3 feet 10 inches.

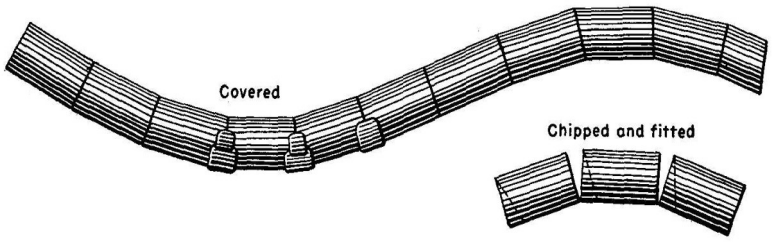
Figure 24: Gage & Line Method.



Target method of establishing grade for a tile drain. Stretch three or more white chalk lines across the trench between upright stakes. Their height above the hubs should be the difference between the depth of cut and the length of the gage stick (usually 5 feet). Sight over the chalk lines and the top of the gage stick. If they line up, the trench is at grade. If the top of the gage stick is above the line of sight established by the chalk lines, the trench is not deep enough; if it is below, the trench is too deep.

Figure 25: Target Method.

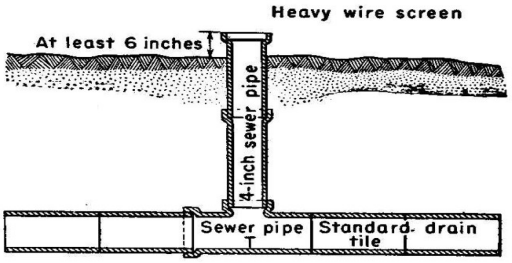
10.2.1 Junctions between laterals and main tile drains should be made with Y's, not T's or elbows. Changes in direction are made by curves and not by sharp angles. Curves should be kept regular with the outer side of the joints covered with pieces of broken tile.



Curves instead of sharp bends should be used in laying out a drain line.

Figure 26: Direction Changes.

10.2.2 Some circumstances warrant the use of relief wells. This occurs when tile drains flatten out and the tile in the flatter part is not large enough to take care of the resulting pressure when there is a heavy flow into the system. These wells are best located at field borders so as not to interfere with mechanical work. The illustration below depicts a relief well.



A pressure relief well made from sewer pipe.

Figure 27: Pressure Relief.

11. AQUIFER RECHARGING: The City of Abbottabad was rescued from a water crisis, in summer of 2000, by the advent of timely rains. The famous springs at Ilyasi Masjid had dried up and a number of the tubwells, bored in the recent past for Municipal Water Supply, were also in the same process. Notices to commercial users had begun to be issued to make their own arrangements for water. This extremely alarming situation was averted in the nick of time. However, it is pertinent to point out that this incident should serve as a timely notice and immediate measures be undertaken to ensure that such a dangerous situation does not arise again. The reasons of this near failure of the water supply are varied. Many have been covered in previous and succeeding sections. However, the most important and immediate cause is lack of aquifer recharge at a rate commensurate with withdrawal. Much Public Money has been expended in the boring of deep wells within the valley of Abbottabad. The aquifer that is already sorely depleted has sunk even further. Firstly, it is necessary to make alternate arrangements for Municipal Water Supply. Secondly, aquifer recharging can be done by the sinking of dry bores and allowing accumulated surface water to penetrate into and thus recharge the aquifer. This pioneering activity will serve as an example for the rest of the Country, which is facing similar problems in and around large urban areas. It is extremely important to note that a great deal of care must be exercised to ensure that no pollution is carried down into the aquifer. The preceding section on Farm Drainage can prove to be a starting point for such an exercise.

11.1 Rash Plain Drainage/ Recharging Complex. The area of the Rash Plain that is effected by poor drainage can serve as a catchment area for recharging. Firstly, it will be necessary to motivate the owners/ workers of the land to organize themselves into a regular Community Based Organization. With organization, the members can ensure that harmful chemicals and sewerage does not enter into the drainage scheme that is outlined in section 10. Once this is ensured, they can construct their drainage scheme with the help of the best technical expertise available. Instead of allowing runoff to drain away, it can be impounded and allowed to settle into the aquifer. This will readily recharge it in the light of heavy rainfall experienced in the area. This subject needs to be examined and studied with great care.

12. **WATER HARVESTING:** Mining of underground water resources at the rate of 49 maf and recharging at a rate of 42 maf, leaves a deficit of 7 maf annually with fluctuations from year to year.[1] Per capita requirements of 1700 cubic meters is the cut off point for renewable water supplies. The present irrigated agriculture has 30 % efficiency in water use, whereas drip and sprinkler irrigation has a 95 % efficiency factor. This also increases yields from 20 to 90 %. In order to use any kind of irrigation it is essential to firstly have water. The increasing aridity of the past few years has amply proved the dire necessity of initiating concentrated efforts towards

[1] Innovative irrigated agriculture, Dr. Zafar Altaf, Federal Secretary MINFAL, 2000.

the harvesting of water. Water harvesting, in this context, means the collection of runoff for productive purposes. The mountainous District of Abbottabad is home to what is the beginning of the Water Towers represented by the Siwaliks and the mighty Himalayas. These watersheds provide the collection point to the large underground aquifers that we have long taken for granted. The problem of recharging aquifers is dealt with separately. At present we are concerned with the collection of excess rainfall, in periods of plenty, to be utilized in an efficient manner in lean periods. Small land holdings mean that such activities can be carried out at lesser cost and yet prove to be cost effective. Requisite water, provided at critical periods, can make intensive agriculture and horticulture very beneficial to those who undertake the required effort.

12.1 Rain Water Catchment Utilization (RWCU): This is the third alternate to surface and groundwater resources. It has some advantages over the first two and these are:[1]

12.1.1 RWCU water costs as little as 1/6th to 1/8th that of long distance truck hauled water.

12.1.2 Investment in RWCU can be repaid in 4-5 years (can be further brought by the use of Ceramic Adobe Technology[2]).

12.1.3 Decrease in runoff, due to harvesting, will be only 0.1 to 0.5 % of total river flow.

12.1.4 Rainwater is less polluted than surface or groundwater.

12.1.5 Rainwater is usually widely distributed and closer to home than surface or deep ground water.

12.1.6 RWCU systems are relatively simple and can be constructed by the end users with little external assistance.

12.2 Micro Water Conservancy Works[3] have proved to be extremely successful and beneficial in China. Vast projects have been undertaken in installing large and small water cisterns. This activity was carried out in hilly areas where other types of water works were not feasible. The project has brought water to the homes and fields of countless, long-suffering peasants. These low cost and quick return projects, are the answer to drought problems for hillside farming.

12.3 Types of Local Water Harvesting Systems: These include:

12.3.1 Rod Kohi[4] Type:

Water cascading down from the hills is stored in a series of successive earthen dams and directed towards the fields as and when required. This is only possible, without conflict, in cases where the local community is organized and water rights are pre-determined. In the Sulaiman Mountains of Baluchistan such a system has long been in practice. Water is only allowed to flow through the main channel and is diverted to side channels when it is excessive. The local farmers have found three ways of saving the fast flowing hill torrents. These are:

a) Pond Systems: Construction of U shaped dikes in the path of the torrent. The water is allowed to spill out of the dike in various directions.

b) Wild Flood System: Water is diverted, from natural courses, towards small impoundment.

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1 Rainwater Harvesting, Saleem A. Sial, ICIMOD, 2000.

2 Khidmat Foundation, ESCAPS Construction Technology, 1998.

3 Micro-Water Conservancy Works, Examples from Deyang City, China, He Yufang, 1999.

4 Indigenous to Pakistan's Sulaiman Ranges, Baluchistan.

c) Level Dike System: Long and level dikes are constructed. Water is allowed to flow in a zig zag manner across the slopes through the entire system. This allows recharge of the aquifers.[1]

Some of the preceding Brush and Wire type Dams can also be utilized. In any case, the local system is functioning adequately and 1,009 cooperatives exist to maintain, utilize and regulate it

12.3.2 Rooftop Harvesting: The construction of large (2,000-Liter capacity) Ferro-Cement jars and placement at the spout that channels rainwater from rooftops has proved to be a relatively inexpensive and proficient system. More than one jar can be linked in tandem as per requirements/ rainfall. It is suggested that Ceramic Adobe Construction can replace this type of material. When combined with homes/ stores construction, the jars can be a viable by-product.

12.3.3 Traditional Spring Water Harvesting: The development of small springs and their roofing/ protection is a long established practice in the NWFP. Excess water can be channeled to irrigate fields.

12.3.4 Concrete Lined Surfaces: This relatively expensive alternate is used to construct tanks or cisterns. Runoff is directed towards these tanks. When combined with a roof, evaporation is reduced. The efficiency of such a system in high.

12.3.5 Plastic Lined Surfaces: This type of lining is much less expensive and cost effective. The pond is lined with black plastic. The plastic can be covered with mud in case animals (water buffaloes) use the water and trample the lining. This type of harvesting is efficient, quick to establish and can be roofed with branches and twigs to provide an inexpensive alternative to the pucca tanks/ cisterns.

12.3.6 Compacted Soil/ Gley Surfaces: An even more inexpensive alternate is to line the bottom of a tank with fresh manure and cover with pegged in banana leaves. The fibrous material decays to block up the soils pores and a relatively efficient water retention capacity is established. Such types of tanks have the added advantage of holding fish as the material provides nutrition to microscopic algae that is their food.

12.3.7 Roads and Paved Surfaces: Existing roads and paved surfaces can benefit greatly by the construction of storm drains. These drains can lead towards storage systems and provide a source of harvesting the runoff.

12.3.8 Contour Line Ditching: Small holding tanks are constructed along natural drainage waterways or courses. This can also be done along the contour line for feeding water to lower fields, as and when required. These holding tanks can be of any of the above materials or types.

12.4 Storage Sub-systems: These are of the following types:

12.4.1 Water cellar.

12.4.2 Water tank.

12.4.3 Water jar/ cistern (above and underground or roofed).

12.4.4 Ponds/ reservoirs.

12.5 Water Use Efficiency; In order to ensure success of the harvesting scheme it is necessary to use harvested water in a wise and appropriate manner. Some of this is covered in a later section.

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[1] Water Harvesting for Mountain Households in Pakistan, Dr. Zafar Altaf, federal Secretary MINFAL, 1999.

13. **GRASS WATERWAYS:** A natural or man-made waterway, protected with a sod cover, is what is meant by grass waterways. Natural waterways are usually the best alternate. In case these are of insufficient capacities to meet runoff requirements. Or if they interfere with cultivation, man-made waterways can be established and seeded with a good sod grass. The dense vegetation and fibrous roots of the sod grass are the best cover to protect a soil from erosion. Most of the Terraces and cultivated slopes in the District do not make use of this arrangement. This results in massive soil erosion and consequent loss of valuable and fertile topsoil. It will be of great benefit to channel water from terraces or from rows of cultivated fields into existing natural waterways. For this purpose artificial waterways will have to be developed.

13.1 Size: The expected heaviest runoff, in a ten year period, will be the major determining factor in sizing a water channel. Width and depth must cater for this flow, to ensure success and the protection of such a measure. Large waterways that are designed to service large areas can also be used as pastures. In such a case it is advisable to keep the waterway on the larger side in order for it to cater to this dual usage.

13.2 Shape: A dish or parabolic shape is ideal for a waterway. This design spreads the water and avoids great depth while maintaining large capacity. It is also easy to construct. The V shaped waterway will work well if the top width is 12 times the depth. This type can be modified to have a flat bottom resulting in a trapezoidal cross-section. The nature of water flows cause parabolic shaped natural waterways. Similarly trapezoidal or V shaped waterways will also develop a parabolic shape with the passage of years.

The parabolic, or saucer shaped, waterway is best suited

Figure 28: Shape of the Ditch.

13.3 Successful Establishment & Maintenance of Waterways:

13.3.1 Waterways should be located in natural drainage paths, whereever possible.

13.3.2 Excess vegetation that might interfere with the flow of water should be cleared away.

13.3.3 In case of seeding a sod grass the seedbed should be prepared in a firm manner. Mulching, to protect soil and seedlings, should be carried out.

13.3.4 Sod grass that is best environmentally suited or native to the area should be used.

13.3.5 Planting should be carried out at the appropriate time.

13.3.6 In case fertilization is required (usually on introduced grasses) it should be done in accordance to the needs of the soil and grass variety.

13.3.7 Over seed to ensure a thick stand and repair bald spots with sod.

13.3.8 Avoid using the waterway as a road, especially when the surface is wet.

13.3.9 Use the waterway moderately for grazing and hay. Allow re-establishment before winter. Avoid grazing/ mowing when grass is wet.

13.3.10 Inspect waterways after heavy rains and repair immediately when required.

13.4 Watersheds: Waterways are an integral part of watersheds. The land surface from which water drains and is channeled into waterways, streams and rivers is called a watershed. A small

watershed protection program should be initiated and implemented in the District. Together these small watersheds form large watersheds or the drainage systems of the District. This program should include:

13.4.1 Forestation and Reforestation.
13.4.2 Waterway improvement.
13.4.3 Repair of Gullies.
13.4.4 Construction of flood prevention check dams.

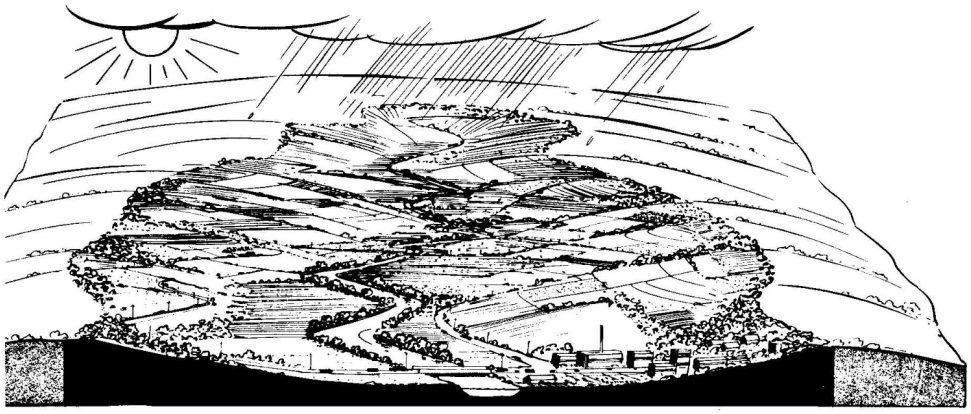
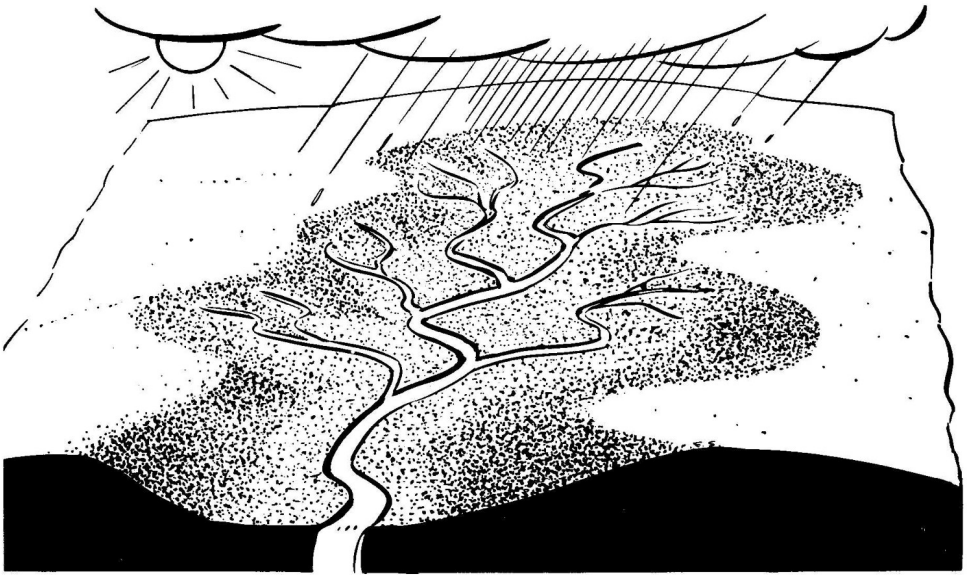


Diagram of a watershed.



Same watershed with surface features removed to show the drainage pattern.

Figure 29: Watersheds.

14. **CONSERVATION IRRIGATION:** Conservation Irrigation means, using irrigated soils and irrigation water in a manner that results in high levels of production, without wasting either soil or water. This involves the combined use of cropping, irrigation and cultural practices that enable a farmer to use his land permanently and also maintain high levels of productivity.

14.1 In other words, Conservation Irrigation results in:
14.1.1 Saving water.
14.1.2 Controlling soil erosion.
14.1.3 Increasing crop yields.
14.1.4 Lowering production costs.
14.1.5 Bringing more land under irrigation as less water is required.

14.2 Conventional Irrigation: Flood irrigation is the conventional irrigation system that is being practiced where water is available. Continuos growing of row crops, without replacing organic content of the soil, results in breaking down of soil structure. The ability of water to enter and flow through the soil and provide moisture to the plants is severely restricted. Water is forced to run off and this results in erosion and loss. Secondly, uneven leveling of the fields results in over irrigation of the upper end of a field in order to ensure that the lower end receives enough water. Over irrigation restricts oxygen intake by a plant's root. This results in damage rather than benefit. The delivery of water in open ditches is another source of water loss by seepage and evaporation. This loss ranges from 25 to 70 % depending upon the nature of the soil, amount of water, climate and velocity of water flow. Weeds growing in water channels slow down the flow of the water and also use water for their own growth. Water is also lost, before it is used for irrigation, due to uncontrolled logging and grazing in the watersheds. This results in a change in the flow patterns of streams and rivers as well as reduced recharging of aquifers. A change in flow patterns means flooding in spring and during the monsoon period and reduced flows during the rest of the year. Additionally, reservoirs and irrigation channels and canals are subject to siltation. This reduces their capacity to hold or carry water. This leads to the added cost of removing the silt or wasted reservoirs.

14.3 Solutions: A thorough working knowledge of the soil, topography, water requirements of various plants and the capability of the land to be irrigated is required in order to be able to use the basic principles of soil and water conservation. Maximum control is exercised over water from delivery to application. Water should wet the root zone, without losses, through deep percolation or runoff.

14.4 On-Farm Conservation Irrigation: This entails the use of irrigation and cropping methods that are best suited to the slope of the land, crop that is being grown and the amount of water supply available. The following steps need to be taken.

14.4.1 Soil & Water Resources Inventory: The land inventory, as discussed earlier, in the shape of a soil conservation survey map is a pre-requisite to good planning. Secondly we must know the amounts, timing and duration of water supply and the possibilities of improving this supply.

14.4.2 Method of Application: Water may be applied to crops in a number of methods. It is necessary to keep in mind available resources and possible alternatives:

a. Reticulation: Sub-soil irrigation through perforated pipes buried in the root zone. This method can be made viable and inexpensive through the use of permanent no-till beds and second hand pipes. It is the most efficient form of irrigation and can be

controlled through the use of inexpensive tensiometers to regulate water supply. This type of irrigation is suited to expensive row crops.

b. Drip Irrigation: This is the supply of water to individual plants either through buried or surface emitters. The NARC has helped to develop inexpensive supplies for this type of irrigation. Secondly, inexpensive alternates such as used glucose drip bags can be used. This type of irrigation is suited to Fruit production and can be automated through the use of tensiometers.

c. Bubbler Irrigation: This is a type of drip system with a modified emitter that enables adaptation of the system to enable use in row crops. The emitter is above ground and more quantities of water are emitted.

d. Moving and Stationery (Solid Set) Sprinkler Systems. The NARC has developed locally manufactured and inexpensive Rain Guns. These rain guns provide a circular wetting zone of fine sprinkled water. Water supply varies from 1 to 2 inches and wetting zone from 100 to 150 feet diameter. The rain gun can be used as a static sprinkler or mounted upon a moving trolley (200 feet lateral move, 100 feet wetting zone). Circular and lateral movements are affected by hydraulic pressure. The only requirement is for piping and pressure pumps. Degree of rotation can be set through simple mechanical stops. The trolley system is best adapted to permanent beds with standby reticulation to make a hybrid system. This system provides the most efficient irrigation that can deliver liquid based fertilizers (safe and stabilized) in precise quantities as and when required. This is known as Fertigation. Obviously the system should only be employed for high value horticulture crops. Stand-alone sprinklers are suited to cereal crop production. However cost of installation renders them cost effective for hybrid maize producing 400 to 500 Kgs per kanal.

The exact amounts of water required depend upon soil and types of crops irrigated. However, a rule of thumb developed through practical application shows that water required for 1 kanal of flood irrigation can irrigate 10 kanals if applied through sprinkler and up to 50 kanals if applied through drip and reticulation systems. Thus where 1 kanal flood irrigation water was available 50 kanals of high production horticulture can be maintained. This represents a substantial increase in income and generation of economy. It is well worth the costs and efforts required.

14.4.3 Planning the Distribution System. The distribution system must ensure that water reaches all parts of the farm. It should be ensured that a minimum amount of land is used and that wastewater can be disposed.

14.4.4 Land Preparation: Maximum efficiency of irrigation entails careful land preparation. Leveling of land must be as precise as possible.

14.5 Conservation Flood Irrigation: Where it is not possible to employ special conservation irrigation systems, conservation flood irrigation can be used. Some of the methods are:

14.5.1 Basin Irrigation: The target field is diked and quickly filled with water to the desired depth. Water is allowed to soak into the soil. This entails the building of holding basins. The size of the basin will depend upon kind of soil and volume of water that can be delivered.

14.5.2 Border Irrigation: In this method narrow strips between low ridges are built and water is allowed to enter from one end and flow through the entire length of the strip. This requires leveling and a uniform grade to prevent ponding. Ridges are low and rounded and are planted with the rest of the strip. This ensures that no land is taken out of production.

14.5.3 Contour or Bench Border Irrigation: This method can be used where Contour Farming is practiced. The strips that are laid out across the slopes are slightly graded to enable smooth flow of water. This method is used where slopes are moderate and soils are deep.

14.5.4 Corrugation Irrigation: The corrugations are closely spaced, small furrows. This method is suited to heavy soils that take in water at a slow rate and seal over and bake hard when flooded. Water is applied to the small furrows and moves through the soil laterally by soaking.

14.5.5 Furrow Irrigation: This method is most commonly applied to irrigating row crops. Water is applied to the furrow between row crops. However, it is important to note that since furrows are cultivated in order to control weeds and often the grade in the furrow is too steep, there is serious possibility of excessive erosion.

14.5.6 Contour Furrow Irrigation: This is a modification to the previous method and is done to restrict the amount of erosion damage. The furrows are made across the slope with just enough grade to permit steady flow. There is a critical grade for each type of soil and it is important to maintain the best-suited grade. This method can be used on slopes up to 8 %.

14.5.7 Broad Furrow Irrigation: This method is used in areas where there is no danger of erosion and an increase in intake of water is desired. This method is suited to orchards planted on the contour and is not suited to slopes greater than 3 %.

14.5.8 Controlled Flooding: Field ditches, that are closely spaced and have frequent openings, are allowed to flood over and irrigate the adjacent fields. Care is taken to prevent the formation of gullies. The frequent openings in the field ditches ensure uniform distribution of water.

14.6 Uses of Irrigation in a Conservation Program:

Table 13: Methods Comparison.

Sr	Method	Adapted To:	Conservation Features
1	Reticulation	High value horticulture crops in permanent beds, orchards, vineyards, berries, medicinal and culinary herbs and aromatic plants. Well suited to environment controlled structures. Can be low cost and is highly cost effective. Any degree of slope that will sustain plants can be irrigated.	Precise control and large savings of water. Eliminates erosion. When automated, the plant dictates its own requirements, resulting in high yields. Denies water to spaces in between plants and thus controls competing weeds. Provides sufficient moisture to plants on sandy soils. Easily adapted to Fertigation.
2	Drip	As above.	As above.
3	Bubbler	As above.	As above.
4	Sprinkler	Nearly all crops on any irrigable soil except in very windy and hot climates.	Adapted to sandy soils. Provides uniform wetting, eliminates erosion and provides high water savings. Easily adapted to Fertigation.
5	Basins	Close growing crops and rice on flat lands with sandy soils.	Good control on water applied. Also good for alkali control

6	Borders	Grain/ hay on 3 % slopes. Established pasture on uniform slopes up to 6 %. Light soils.	Provides uniform wetting and efficient water use. Large quantities of water utilized thus reducing time required.
7	Corrugations	Close growing crops on slopes with slow water intake. Care to be taken on slopes over 2 %	Provides uniform wetting, prevents erosive water accumulation on land too rolling or too steep for borders and basins.
8	Furrows	Coarse textured soils. Row and truck crops, orchards, vineyards and berries on gentle slopes.	No conservation features unless laid on nearly level land, on the contour and water applied with care.
9	Controlled Flooding	Close growing crops on rolling land.	Provides water control and fairly uniform wetting.

14.7 Land Preparation: Conservation Irrigation requires a good deal of land preparation. Grading and leveling and in some cases the building of permanent beds is a pre-requisite. All methods of surface flow irrigation require leveling and grading of land. This is not necessary in sub-soil and drip/ bubbler or sprinkler irrigation. In the case of moving trolley, sprinkle irrigation, a precisely leveled pathway is essential. Where leveling is required the following points must be kept in mind:

14.7.1 Fields, where deep cuts or fill have been made, require planting with an annual crop to allow settling of land. Subsequent touching up of low or high spots should also be carried out, if required.

14.7.2 Avoid heavy cuts on shallow soils. It is recommended to avoid cuts deeper than one-fourth of the usable soil. In light-textured soils at least one and a half to two feet of soil must remain after leveling.

14.7.3 For border irrigation, the fields should be leveled so that no side slope remains.

14.7.4 In fields where more than 4 inches of soil has been removed it is essential to cover with a thick layer of well-rotted manure or compost.

14.7.5 Chiseling or ripping should be undertaken if it is required to make a soil deeper or more easily drained (clay or hard pans).

14.7.6 Plan ditch locations before leveling in order to ensure that the lengths of the runs fit land conditions.

14.8 Distribution Systems: This factor needs attention to the following:

14.8.1 Avoid losses in delivery systems. This can be done, by the lining of channels with Ceramic Adobe tiles, a by-product of ESCAPS Construction Technology. Thus ensuring low cost.

14.8.2 The distribution system must suit the method of irrigation.

14.8.3 Water must reach all parts of the farm when needed and in sufficient quantities to cater to crop needs during peak use periods.

14.8.4 In case of time-bound irrigation it is essential to ensure that sufficient water is delivered in the time allocated.

14.8.5 Where water is delivered to more than one field at a time, accurate division structures should be installed.

14.8.6 Some means of measuring water inflow should be established.
14.8.7 Ditches, pipelines and irrigation structures should be laid out in such a manner as to ensure that minimum land is taken out of production.
14.8.8 Ditches should be sited to avoid steep grades or grade changes within the irrigation run.
14.8.9 Open ditches should have sufficient grade to allow water flow but not so much as to cause erosion.
14.8.10 Pipelines should be designed and installed in a manner to avoid damage from high pressure.
14.8.11 Trash, debris and weeds must be excluded from water delivery systems.

15. **FARM CONSERVATION & SUSTAINABLE DEVELOPMENT PROGRAM:** An illustration of a supposed Conservation & Sustainable Development Program is detailed to bring home various features:

15.1 Present Situation: A fifty kanals farm, located in Banda Phugwarian, is owned by Gohar Rehman, two sons assist him on the farm. Total persons in household, 4 adults and 5 children. They own 2 buffaloes and five goats, some milk is sold to augment income (Rs. 7,000.00 per annum). The farm is presently used as follows:
15.1.1 Cropping Pattern: Rainfed Wheat (reported yield 80 Kgs. per kanal/ 640 Kgs. per acre, market value Rs. 25,000.00 per crop) followed by Rainfed Maize (reported yield 100 Kgs. per kanal/ 800 Kgs. per acre, market value Rs. 28,000.00) on 40 kanals gently sloping land 2 % (5 acres). Estimated income equivalent Rs. 5,000.00 per month.
15.1.2 Pasture: 8 kanals of sloping land with 5 % slope, some gullying.
15.1.3 Homestead; 2 kanals with 2-room adobe home without latrine facility, ½ kanal kitchen garden and cattle sheds. A ½ kanal pond exists for watering domestic cattle. Some poultry are raised.
15.1.4 Water Source: A one inch 80 foot bore with ¾ inch delivery, hand pump.
15.2 Weakness:
15.2.1 No farm Drainage.
15.2.2 Pond not productive.
15.2.3 Soil fertility and consequent crop productivity very low.
15.2.4 Insufficient pasture for cattle.
15.2.5 No summer or winter covers.
15.2.6 No terracing.
15.2.7 No trees.
15.2.8 No irrigation.
15.2.9 Soil erosion beginning to be serious.
15.2.10 Income low, children spending all their time helping on the farm.
15.3 Collect Data for Conservation Program.
15.3.1 Carry out Macro, Secondary and MicroNutrient analysis of soil and leaf tissue of any crop in production.

Subject: Att: Sardar Taimur Hyat-Khan
Date: Tue, 31 Oct 2000 14:01:44 +0500
From: "DR. TAHIR HUSSAIN" <deanagri@fsd.paknet.com.pk>
Organization: Dean, Faculty of Agriculture, University of Agriculture, Faisalabad.
To: <iucnacs@atd.hazara.net.pk>

Sardar Taimur Hayat Khan,
Project Manager,
IUCN, Abbottabad,
NWFP, Pakistan.

Subject: **ELEMENTAL ANALYSIS**

With reference to your letter No. nil, dated 10.10.2000, referred by the Dean Agriculture, UAF, in regard to the analysis of leaf samples A2 & B2, the results are enclosed.

Sample Element Conc. (ppm)

	Zn	Fe	Cu	Pb	Co	Ni	Mn	Cd	Cr	Ca	Mg
A-1	121	13800	53	19	nil	333	330	nil	318	9890	17640
A-2	129	43140	68	147	nil	25	669	nil	05	26460	28440
B-1	182	12090	53	14	nil	308	124	nil	98	12030	9360
B-2	139	39990	44	39	nil	39	665	nil	36	20790	4120

Dr. Tahir Hussain
Dean Faculty of Agriculture
Faisalabad.

Table 14: Secondary and MicroNutrient Analysis.
Where: A1 is a soil sample from Kitchen Garden Plot growing Lettuce.
A2 is a leaf tissue sample of Lettuce from Kitchen Garden Plot.
B1 is a soil sample from a Maize field.
B2 is a leaf tissue sample of Maize.

15.3.2 Carry out Land Inventory.

Table 15: 42 kanals.

Sr	Characteristic – Range.	Descriptive Term	Symbol
1	Effective Soil Depth	30 inches (Moderately deep)	3
2	Topsoil texture	Clay loam, Fine (Heavy)	H
3	Soil permeability	0.7 inches/ hr. Fine soil, moderately slow	3
4	Slope	2 % Gently sloping	B
5	Erosion	50 % Moderate erosion	2

3H3/ 2B-2
Land Class: 42 kanals Class III

Table 16: 8 kanals.

Sr	Characteristic – Range.	Descriptive Term	Symbol
1	Effective Soil Depth	8 inches Very shallow	5
2	Topsoil texture	Lighter Clay loam, Medium	M
3	Topsoil texture modifier	Fragments > 10 inches dia. Stony	s
4	Soil permeability	0.4 Medium, Moderate	4
5	Slope	5 % Moderately sloping	C
6	Erosion	80 % Severe erosion	3

5sM4/ 5C-3
Land Class 8 kanals Class V.

15.3.3 Carry out Physico-Chemical Analysis of sub-surface water.

NUTRITION DIVISION
NATIONAL INSTITUTE OF HEALTH, ISLAMABAD.
PHONES [illegible] 9255090-4/3133

PHYSICO-CHEMICAL EXAMINATION OF WATER

Laboratory Code : 200 WR-848 Date : 24-10-2000
Senders Name : Sardar Taimur Hayat.
Address : IUCN The World Conservation Union Abbottabad NWFP Pakistan.
Source : No.2, Residential Sample Location : Hand Pump Banda Phugwarian.
Brand Name : - Specimen No. : 02

Analytical Parameters	Ref. Values	Results	Analytical	Ref. Values	Results
Calcium	< 200.0	58.0	Chloride	< 200.0	27.48
Chlorine	< 0.3	Nil	Nitrate	< 10.0	10.53
Magnesium	< 150.0	15.60	Sulphate	< 200.0	-
Sodium	< 200.0	25.0	Nitrite	< 0.1	Nil
Hardness	< 500.0	210	Bicarbonate	< 500.0	213.57
Potassium	< 100.0	1.0	Iron	< 0.3	-
Ozone	< 0.5	-	Fluoride	< 1.5	-
Total Dissolved Solids	< 1000.0	339.75	Suspended Solids	Nil	Heavy sedimentatio
pH Value	6.5 - 8.5	6.83	Colour	Unobjectionable	Colourless
Turbidity	< 5.0 NTU	-	Odour	Unobjectionable	Odourless
Conductivity	< 1334 uS/cm	453	Taste	Unobjectionable	-

Hardness ☑ Acceptable ☐ Unacceptable
Organoleptic ☑ Acceptable ☐ Unacceptable
Total Dissolved Solids ☑ Acceptable ☐ Unacceptable
Potable Water Quality ☐ Satisfactory ☐ Unsatisfactory
☑ Satisfactory except suspended solids

Per iodical monitoring should be required because of boarder line high value of nitrate contents.

OFFICER INCHARGE
WATER TESTING LABORATORY
Date : 25/x/00

CHIEF
NUTRITION DIVISION
Date : 27-X-2k

Figure 30: Physico-Chemical Analysis.

15.3.4 Carry out Bacteriological Analysis of sub-surface water.

NUTRITION DIVISION

NATIONAL INSTITUTE OF HEALTH
ISLAMABAD

PHONE NO. 9255090-4/3140

BACTERIOLOGICAL EXAMINATION OF WATER

DATE 17-10-2000 LAB.CODE NO. 240/2000-Wm

Name & Address of Agency / Deptt Sardar Taimur Hayat Khan IUCN The World Conservation Union Abbottabad NWFP Pakistan.

Source Residential Sample Hand Pump Banda Phugwarian No.2

Brand Name if any -

Mode of collection Sample was collected by the applicant.

Reference No -

Date received 11-10-2000

Physical examination -

Nature of sample Residential Sample Hand Pump Banda Phugwarian No.02

Packing : Bottle/Others Sterilized Bottle

LABORATORY FINDINGS :

1. Total viable count $1x10^4$ per/ml
2. Coliform count $3x10^3$ per/ml
3. MPN for coliforms 240^+ per/100 ml
4. MPN for faecal coliforms Negative per/100 ml

REMARKS: According to PSI Standards for drinking water the sample was found unsatisfactory due to high viable counts and coliforms contamination (Intermediate Risk).

Authenticity of the sample rests with the applicant.

OFFICER INCHARGE LAB. 19/10/00 CHIEF 19.X.2K

Figure 31: Bacteriological Analysis.

15.4 Analysis: The farm lies on Piedmont Alluvial Plains. Soil consists of Heavy and Lighter Clay Loam. Temperature ranges from –2 degrees C in January to 26 degrees C in June. Average yearly humidity is 60 %. Average yearly wind speed is 1.4 kts and total precipitation is 2700 mm per year (30 years average). Soil is subject to erosion on the slopes. Drinking water is above the borderline for Nitrate levels (10.53 against upper level of 10.00 mg/ L). This is probably due to excessive use of Nitrate Nitrogen Fertilizer and subsequent leaching into the ground water. There is intermediate risk in drinking water rendering it unsatisfactory to drink. This is due to high viable counts and coliforms contamination. Soil Fertility levels are low, iron is tied down

chemically and unavailable to the plants. There is excess of Lead, Chromium and Nickel probably due to vehicular emission from vehicles passing on the nearby road. Zinc and Calcium levels are unsatisfactory while Cobalt is absent. Organic content of soil is poor and method of storing farmyard manure leads to leaching of nutrients. Crop productivity is miserable. This is probably due to poor and wrong fertilization with unbalanced and unstabilized chemical fertilizers (100 Kgs. Urea and 50 Kgs. Diammonium Phosphate per acre, twice a year).

15.5 Sustainable Development Suggestions:

15.5.1 Sink 4 inch Bore with 2.5 inch Delivery (Rs. 25,000.00).

15.5.2 Procure two Static Rain Guns (2 inch) with accompanying plastic piping and pressure pump (Rs. 30,000.00).

15.5.3 Procure one Moving Rain Gun Trolley (1.25 inches) with accompanying plastic piping (Rs. 20,000.00).

15.5.4 Procure Drip Irrigation System for 4 kanals (Rs. 32,000.00).

15.5.5 Procure second hand piping (1 inch) for 2 kanals Permanent, Pakistani, No-Till beds with Reticulation (Rs. 3,000.00)

15.5.6 Establish one Environment Protected Wah Garden 10 square meters (Rs. 1,500.00).

15.5.7 Establish Permanent Composting beds, 8 square meters.

15.5.8 Establish small adobe hen house and procure 50 layers (Rs. 10,000.00).

15.5.9 Procure small hand operated, K2 oil heated incubator (Rs. 3,000.00).

15.5.10 Carry out Strip-cropping and establish Crop Rotation on 4 acres (Rs. 10,000.00 revolving working Capital).

15.5.11 Plant ½ acre drip irrigated Fruit orchard (Rs. 3,000.00).

15.5.12 Establish and plant ¼ acres Permanent, Pakistani, No-Till beds for High value vegetables (Rs. 16,000.00 revolving working Capital).

15.5.13 Level and prepare ½ acre for moving rain gun trolley irrigated market vegetables (Rs. 5,000.00 revolving Capital and Rs. 1,000.00 labor and machinery).

15.5.14 Re-seed 1-acre sloping land with suited grasses, forbs and shrubs (Rs. 1,000.00).

15.5.15 Sell goats and buy 4 sheep.

15.5.16 Sell buffaloes and buy 2 Mixed Breed Cows (Rs.18,500.00).

15.5.17 Improve pond, line with plastic, cover with branches and divert runoff towards inlet. Provide for over flow (Rs. 1,000.00).

15.5.18 Improve natural waterways and repair gullies (Rs. 1,000.00).

15.5.19 Miscellaneous Charges, electricity, stores, fertilizers, selling costs, machinery hire etc. (Rs. 19,000.00 revolving working Capital).

15.5.20 Total Investment:

Rs. 1,50,000.00 Fixed.

Rs. 50,000.00 Revolving Working Capital.

TOTAL Rs. 2,00,000.00

A loan of Rs. 2,00,000.00 at 14 % interest, repayable in monthly installments over 7 years after a 6 month initial period, at the rate of Rs. 15,000.00 per quarter.

15.5.21 Planting Program:

Table 17: Plantings and Expected Returns.

Sr.	Plant	Acreage	Expected Return
1	Wheat	2 acres	Rs. 25,000.00
2	Maize	2 acres (subsequent)	Rs. 22,000.00
3	Small Grains	1 acre	Rs. 8,000.00
4	Lucerne	1 acre (subsequent)	Rs. 10,000.00
5	Peas	1 acre	Rs. 16,000.00
6	Cumin seed	1 acre (subsequent)	Rs. 20,000.00
7	Cauliflower	½ acre	Rs. 8,000.00
8	Radish	½ acre (subsequent)	Rs. 4,000.00
9	Spinach	½ acre (subsequent)	Rs. 2,000.00
10	Onions	½ acre (subsequent)	Rs. 4,000.00
11	Green Chilies	¼ acre	Rs. 8,000.00
12	Tomatoes	¼ acre (subsequent)	Rs. 5,000.00
13	Broccoli	¼ acre (subsequent)	Rs. 8,000.00
14	Iceberg lettuce	¼ acre (subsequent)	Rs. 10,000.00
15	Milk	per annum	Rs. 8,000.00
16	Poultry	per annum	Rs. 10,000.00
	Total	per annum	Rs.1,68,000.00

Rs. 14,000.00 per mensum.

15.6 Payment of Rs. 15,000.00 per quarter towards interest and loan amount will still leave an equivalent of Rs. 9,000.00 per month income for the farmer. This represents a Rs. 4,000.00 per month increase (80 %) over his previous income. With increasing skills, eventual fruit production and gradual expansion of horticulture he should be able to increase his standard of living to quite a large extent. The savings made to the soil are not quantifiable in financial terms. The development is sustainable and he will be able to leave a substantial patrimony to his children along with a decent education and other employment prospects.

15.7 It is definitely possible to make a sustainable difference. Concentrated action at the Grass Roots level with Organization and Capacity enhancement is all that is required. In a District like Abbottabad, where quite of few of Natures Bounties remain, the time to act is now! Some of the Western Districts of the NWFP are facing much greater degradation and unfavorable weather. There the task is so much the more difficult. Never the less, when Terraforming on Alien landscapes is possible; rehabilitation of the Rural Landscape is definitely possible. All that is required is **Vision, Determination, Dedication and a lot of Hard Work**!

CHAPTER 6: HERBS (Medicinal & Culinary), SPICES, CONDIMENTS & AROMATIC/ ESSENTIAL OIL PLANTS:

1. **INTRODUCTION**: The above caption already brings out the wide variety of plants that lie within this bracket as well as the range of possibilities inherent within them. Agricultural commodities are as varied as the living abundance of Nature. Throughout history this particular group of agricultural commodities has played an important role in the commercial life of mankind. We all know the common saying, to add spice to ones life. These commodities have added spice to the economies of many civilizations and made them sustainable. The Indo-Pak Sub Continent has been known, throughout the World, as a major producer of herbs and spices. Herbs have been used to soothe pain and heal wounds. They are forms of food that contain vitamins and minerals. Herbs are natural drugs that work well and cause the least amount of discomfort. Hundreds of years ago the Arabs discovered that when horses and camels, that were ailing, had a chance to graze upon a particular grass, they were soon better. They called this variety Alfalfa or The Father of all Foods.[1] One look at the statistics of Alfalfa is enough to convince even the most skeptical of critics. Two tablespoons full of Alfalfa extract contain:

1.1 Twice as much Calcium as an ordinary glass of milk.
1.2 Almost as much protein as one fried beefburger.
1.3 Nearly the same amount of iron as two ounces of liver.
1.4 Enough B complex for the most jangled nerves.
1.5 Plenty of enzymes for good metabolism of ingested fats.
1.6 Sufficient fiber to lower the highest cholesterol.

In Abbottabad District, with a mild summer and cold winter**,** it is possible to grow a large variety of the more expensive and rare plants that fall within this group. Indeed, the list of naturally growing, indigenous plants is quite long and further research is bound to reveal many a hidden and even threatened treasure waiting to be discovered. Secondly, many of the valuable and export-oriented herbs and Essential/ Perfume Oil plants can be grown to furnish a prosperous Cottage Industry. Farmers who are engaged in the commercial growing of these minor cash crops are called enlightened. Their returns are greater and lives more rewarding. Perhaps the oldest distillation plant for the extraction of essential oil has been discovered in Harrapa. Unfortunately this art is practically lost in Pakistan. Rising market demand of herbs and essential oils, in developed Countries, has prompted them to grow herbs under expensive cover to catch the early spring and late fall markets. It is in these market niches where a comparative advantage can be obtained by appropriate manipulation of the growing process[2] (Inexpensive, Environment Controlled, Kitchen Garden Structures with Community growing for export). Joint Ventures with Foreign Importers should be examined. European consumption lies in the use of fresh culinary herbs, herbs used in pharmacy, perfumery or as insecticides and fungicides. An estimate from the Agri Business cell, way back in 1994, revealed that 75 % of Imports into Europe consisted of six herbs: Sage, Oregano, Marjoram, Mint, Thyme and Rosemary. Parsley is the most used herb but demand is met by local production. Other herbs are Basil, Bay leaves, Savory, Tarragon and Dill. Tariffs are not a problem. However, stringent quality requirements, phytosanitary control regulations and the closed distribution network for retail packs are the difficulties that have to be surmounted.

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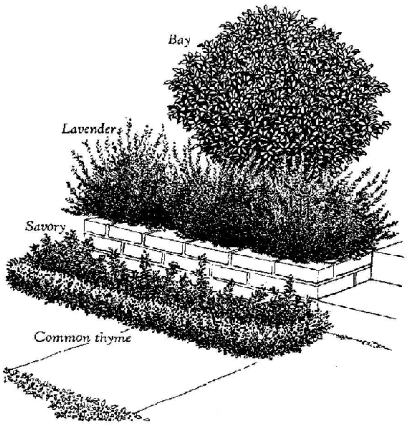
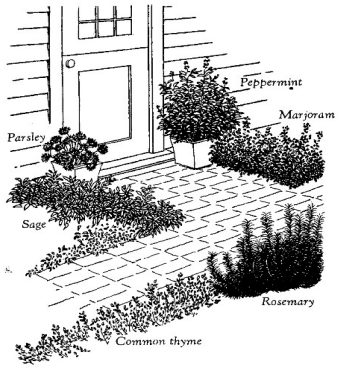
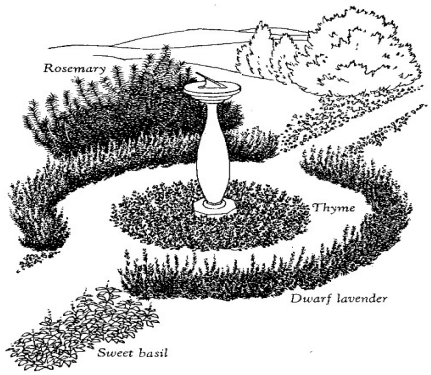
1 Healing Power of Herbs, Dr. John Heinerman, 1975.
2 Herb Farming for Potential European Market, ABC, MINFAL, 1994.

The word herb is derived from the Latin *herba*, which means grass. There are three generally accepted[1] definitions of an herb. Botanically, herbs are non-woody annual, biennial (plant that completes its life cycle in two years, without flowering in the first year) and perennial plants that die back each year after blossoming. Another definition describes them as any of the herbaceous plants valued for their flavor, fragrance, or medicinal properties .In cooking; distinction is made between spices and herbs. Spices are usually considered to be derived from the root, bark, fruit or berries of perennial plants. Herbs are the leaves only of low growing shrubs and herbaceous plants. The International Organization for Standardization (ISO) states that there is no clear-cut distinction between spices and condiments. As such they are grouped together. These terms are applied to natural plants or vegetable products or a mixture thereof, in whole or ground form, as are used for imparting flavor, aroma and piquancy to and for the seasoning of







food. Plant parts, flowers, leaves, fruit and seed contain and emit sweet and pleasant aromas. They are used extensively in the perfume and food industry all over the World. There is a growing trend in trade in these plants and their extracts.[2]

1 How to Grow Herbs, A Sunset Book, 1975.

2 Illustrations from How to Grow Herbs, A Sunset Book, 1975 and Natural Home Remedies, Karen Sullivan, Time-Life Books, 1997.

2. MEDICINAL HERBS OF ABBOTTABAD DISTRICT:

The herbs that are presently growing in the wild and so far documented are:

TABLE 1: MEDICINAL HERBS OF ABBOTTABAD DISTRICT:

Sr No	Botanical Name	English Name	Local Name
1	*Acacia nilotica*		Kiker
2	*Achillea millefolium*	Yarrow	Saunfi Booti
3	Adiantum incisum	Spleenwort	Kakh pai
4	*Aesculus indica*	Chestnut	Bankhoro
5	*Althea rosae*	Hollyhock	Gul-e-Khaira
6	*Arisaemae flavum*	Indian Turnip	Adbis
7	*Artemisia fragans*	Wormwood	Chau
8	*Berberis lycium*	Barberry	Sumbul
9	*Bergenia stracheyi*		Bhat Phae
10	*Cannabis sativa*	Indian Hemp	Bhang
11	*Carum petroselinum var. crispum*	Parsley	Bhat Jhata (Ajmud)
12	*Cedrus deodara*	Indian Cedar	Diar
13	*Citrullus colocynthis* (Indrayan)	Colocynth	Kor Tambacoo
14	*Coptis teeta*		Moomera
15	*Cynoglossum lanceolatum*	Hounds Tongue	Cheru
16	*Dryopteris ramosa*	Male Fern	Pakha
17	*Ephedra vulgaris*		Asmani
18	*Euphorbia wallichi*	Spurge	Hirvi
19	*Fragaria nubicola*	Wild Strawberry	Panjakha
20	*Geranium wallichianum*	Cranesbill	Ratanjot
21	*Galium aparine*	Clivers	Coochan
22	*Hedera nepalensis*	Ivy	Albhumbar
23	*Indigofera heterentha*	Indigo	Kainthi
24	*Isodon surgosus*		Bui
25	*Juglans regia*	Walnut	Akhor
26	*Juniper communis*	Juniper	Bay Nar Natha
27	*Paeonia emodi*	Peony	Mamaikh
28	*Plantago major*	Plantain Common	Chamchi Patra
29	*Podophylum emodi*	Indian Mandrake	Bankakri
30	*Polygonum amplexicaule*	Knotgrass	Masloon
31	*Ricinus communis*	Castorbean	Arind
32	*Rosa muscatta*	Musk Rose	Jhal
33	*Rumex nepalensis*	Mountain Sorrel	Hula
34	*Senecio saligna*	Mountain Groundsel	Chita Hula
35	*Skimmia laureola*		Ner
36	*Sonchus aspera*	Mountain Thistle	Hand
37	*Solanum miniatum*	Black Nightshade	Katch Mach

38	*Swertia chirata*		Churiata
39	*Taxus wallichina var baccata*	Banyan	Barmi
40	*Ternunalia arjuna*		Anjani
41	*Valeriana wallichii*	Valerian Indian	Mushik Bala
42	*Viola canina*	Violet	Suar Phul
43	*Nepeta laevigata*	Ground Ivy	Mushkana
44		Pakistani Atis	Patis
45			It Sit

Keys:[1]

PHC1: Major use in Primary Health care.
PHC2: Other secondary uses in Primary Health care.
AHC: Animal Health care.
C: Cultivation.
P: Propagation.
Proc: Processing.
OU: Other Uses.[2]
RP: Research priority.

2.1 KIKER.

Acacia nilotica	(Kiker).
PHC1:	Decoction of bark used for vaginal infections.

2.2 SAUNFI BOOTI.

YARROW (*Achillea* species)

Plant: perennial, hardy to —30°
Height: 8 inches to 5 feet
Soil: average, dry
Exposure: sun, partial shade
Propagation: division
Uses: landscape only

Achillea millefolium	Yarrow (Saunfi Booti)
PHC1:	Diaphoretic, anti-inflammatory, antiseptic, antispasmodic, diuretic. Fever, Flu, Head Cold, Arthritis,
PHC2:	Tooth aches, Ear ache. Leaves and stem useful for heart diseases. Supportive for people undergoing Radiotherapy.
AHC:	Scab in Sheep (ointment).
OU:	Vulnerary (helps heal wounds and sores by external application), styptic, piles, rheumatism, kidney disorders. Contains nitrates, phosphates and chlorides of potash and lime: Recommended as an additive for Composting! Evaluated as a possible alternate source for

1 Womens Indigenous Knowledge of Folk Medicines, IC - PHP, LEWW, ERP, 1999
2 Compilers addition.

	rubber.
C:	Wild, can be cultivated.
P:	Seed and root.
Proc:	Tea: 1 oz dried herb, 1-pint boiling water, flavor with peppermint.
RP:	Cultivation.

2.3 KAKH PAI.

Adiantum incisum	Barberry *(*Kakh pai).
PHC1:	Hypothermic/ lung infection.
PHC2:	Troublesome cough.
P:	Likes a northern aspect, shade and shelter. Thrives in moist, damp conditions.
OU:	Hair wash.

2.4 BANKHORO.

Aesculus indica	(Bankhoro).
AHC:	Open wounds in sheep and goats. Flu and cough in sheep and goats. Used to relieve stomach pains in horses.
Proc:	Internal use fruit is crushed and mixed with feed. External use oil is extracted from the fruit and applied to the wound.
RP:	Cultivation.

2.5 GUL-E-KHAIRA.

Althea rosae	Hollyhock (Gul-e-Khaira).
PHC1:	Emollient (softens and soothes skin, demulcent (protects mucous membranes and allays irritation) and diuretic. Jaundice.
PHC2:	Liver and digestion.
Proc:	Roots chopped into fine pieces and steeped in water for 24 hours. Small quantities drunk on empty stomach before breakfast every day.
OU:	Flowers used for coloring collected July to August, freed of calyx. Dried in trays in thin layers with current of warm air flowing.
RP:	Cultivation.

2.6 ADBIS.

Arisaemae flavum	Indian Turnip (Adbis).
AHC:	Control for Poultry disease "RaniKhet".
Proc:	Ripe seeds 8 to 10 fed twice daily to sick birds.
OU:	Ground dried roots placed under milk vessels believed to keep milk from turning sour, especially when the milk of two types of animals is mixed and kept in the same vessel.

WORMWOOD (*Artemisia* species)

Plant: perennial, hardy to —30°

Height: 1-4 feet

Soil: dry, poor

Exposure: sun

Propagation: cuttings, division

Uses: culinary, fragrance

2.7 CHAU.

Artemisia fragans	Wormwood (Chau).
PHC1:	Antiseptic, treatment for Stomach worms. Rapidly expels roundworms and also effect threadworms.
PHC2:	Tooth ache, Earache and Asthma.
C:	Likes a shady place. Easily propagated by division of roots in the autumn, by cuttings, or by seeds sown in the autumn soon after they are ripe. Keep free from weeds. Plant 2 feet apart each way.
Proc:	Leaves are crushed to extract juice.
OU:	Though the variety fragans has not been identified, the alpine variety makes a pretty border as a garden plant. It is also used as a rockwork shrub.

2.8 SUMBUL.

Berberis lycium	Barberry (Sumbul).
PHC1:	Backache and healing of broken bones. Bitter tonic, antiperiodic, diaphoretic (causes sweating).
PHC2:	Root juice used to relieve fever, febrifuge, eye diseases and chronic diarrhea.
P:	Best by layering. Set down branches in Autumn (October). When well rooted is ready for transplanting next Autumn.

2.9 BHAT PHAE.

Bergenia stracheyi	(Bhat Phae).
PHC1:	Duodenal ulcers, dyspepsia, and bronchitis.
PHC2:	Open external wounds.
AHC:	Animals dyspepsia, joint pains and to increase female fertility.
OU:	Leaves used for making a tanning material.
Proc:	Pieces of root mixed with milk and sugar for internal use, taken before breakfast on empty stomach. Dry powder applied for external use.
RP:	Cultivation.

2.10 BHANG.

Cannabis sativa	Indian Hemp (Bhang).
PHC1:	Ease pain and ease sleep. Soothes nervous disorders. Used in neuralgia, gout and rheumatism. Tonic, stomachic, antispasmodic, analgesic (remedy or agent that deadens pain), narcotic and anodyne.
PHC2:	Treatment in delirium Tremens, insanity, infantile convulsions and painful urinary diseases.
AHC:	To increase appetite in cattle, which are off feed.
Proc:	Leaves crushed and fed to cattle with roti.
OU:	Used to cure dandruff in humans, juice extracted from the leaves applied to the hair.

2.11 BHAT JHATA (AJMOOD).

Carum petroselinum var. crispum	Parsley {Bhat Jhata (Ajmood)}
PHC1:	Carminative (settles the digestive system, relieves flatulence), tonic, diuretic (aids production of urine, promotes urination, increases flow), embolic, antipyretic (agent that reduces fever) and aperient (a mild laxative) action. Chief use for diuretic properties. A strong decoction of the root is of great use in gravel, stone, and congestion of the kidneys. Oil extract Apiol is of considerable medicinal value is used as a emmenagogue (induces or assists menstruation). Used in ague and malarial disorders.
PHC2:	Exercises a singular influence on the great nerve centers of the head and spine.
AHC:	When thrown into fishponds the sick fish are said to be healed. Hoof rot in sheep.
Proc:	Fluid extract from roots and seed. Oil extracted from the seed or rather fruit.
C:	Ordinary, good well worked soil. Moist conditions with partial shade are the best. Three sowings give a good supply, as early as possible in February, April or early May, June or early August. The last is for a winter supply and should be sown in a sheltered position with a south exposure. Seed can be broadcast and only 0.5 inches soil cover is required. If planted by drill the plants should be 1 foot apart. Pricking of plantlets is practiced, as plants do not like to be cramped. Each plant requires 1 square foot of space. Liberal watering is required in warm weather. If growth becomes coarse in summer cut off all leaves and water well. This ensures a new growth of fine leaves on a stocky stem. Beds need renewal every two years.
P:	Seed germinates best in April. Mid August sowing enables plants to be put into cold frames for winter use.
OU:	3 essential oils obtained from Parsley, Seed oil, Leaf oil and Herb oil.

2.12 DIAR.

Cedrus deodara	Deodar (Diar).
PHC1:	Tonic for weakness. Phthisis, bronchitis and blennorrhagia. Mixed as 25 % with vaseline and used for eruptions of the skin. Oil is analgesic and alexipharmic.
AHC:	Skin irritations of animals.
Proc:	Bark cut into fine pieces and boiled in water. Drunk in small quantities.
OU:	Distilled oil Libonal. Satinwood.

2.13 INDRAYAN.

Citrullus colocynthis	Colocynth (Indrayan).
PHC1:	Snake bite.
PHC2:	Epilepsy, diarrhea, Cholera.
OU:	Powdered root used as insecticide.

2.14 MOOMERA.

Coptis teeta	(Moomera).
PHC1:	Swelling of the eyes.
Proc:	New buds and leaves crushed and applied as a poultice (therapeutic application of a soft moist mass to the skin to encourage local circulation and to relieve pain).

2.15 CHERU.

Cynoglossum lanceolatum	Hounds Tooth (Cheru).
PHC1:	Cure for cough and colds. Is soothing to digestive organs.
PHC2:	Shortness of breath. Used internally and externally to relieve piles.
Proc:	Fresh stems are chewed and juice is swallowed.

2.16 PAKHA.

Dryopteris ramosa	Male Fern (Pakha).
PHC1:	Vermifuge for ringworm and tapeworms. Duodenal ulcers, and constipation.
PHC2:	General weakness.
Proc:	Small leaves broken in March and May. Cooked as vegetable and eaten.

2.17 ASMANI.

Ephedra vulgaris,	(Asmani).
PHC1:	Used in circulatory collapse/ shock, stimulant and anti-allergic, asthma and hay fever. Sympathetic nerve stimulant resembles adrenaline.
PHC2:	Clears the respiratory system relieves swelling of mucous membrane.
OU:	Commercial source for natural ephedrine.
P:	Possible from seed and root cuttings.
Proc:	Infusion of leaves and roots. Nasal ingestion of juice extracted from seeds for respiratory system.
RP:	Commercial crop cultivation.

2.18 HIRVI.

Euphorbia wallichi,	Spurge (Hirvi).
PHC1:	Skin diseases.
Proc:	Milk from the leaves rubbed on affected part of skin. Cures in a single application.

2.19 PANJAKHA.

Fragaria nubicola,	Wild Strawberry (Panjakha).
PHC1:	Laxative, diuretic, astringent (constricts the blood vessels or membranes in order to reduce irritation, inflammation and swelling) and cure for Peptic ulcers.
PHC2:	Antiseptic, berries cure rheumatic gout.
Proc:	Fruit and leaves crushed, mixed with *Berbis lycium* leaves, eaten or applied externally.
C:	Grown in a sheltered position.

2.20 RATANJOT.

Geranium wallichianum	Cranesbill (Ratanjot).
PHC1:	Hepatitis and joint pains.
PHC2:	Astringent properties.

2.21 COOCHAN.

Galium aparine	Clivers (Coochan).
PHC1:	Diuretic, tonic, alternative and aperient. Heals wounds and purifies blood.
PHC2:	Jaundice, scurvy, scrofula, psoriasis, and skin diseases. Soothing effect

	in insomnia by inducing quiet and restful sleep. Ointment used on cancerous growth at the same time extracted juice is imbibed. As a wash for sunburn and freckles.
Proc:	Entire plant bound over wound till healed. Juice extracted from crushed plant imbibed once daily till jaundice cured.
OU:	Best substitute for coffee.

2.22 ALBHUMBAR.

Hedera nepalensis.	Ivy (Albhumbar).
PHC1:	Diabetes.
PHC2:	Stimulant, used to activate movement of bowels.
AHC:	To increase lactation in milch animals. Fodder for small ruminants in winter.
OU:	Provides berries for birds in winter.
Proc:	One leaf on first day, increased by one each day until ten on the tenth day as cure for diabetes.

2.23 KAINTHI.

Indigofera heterentha	Indigo (Kainthi).
PHC1:	Abdominal pains.
Proc:	Procedure for obtaining the World-renowned Indigo from var. tinctoria as it does not exist ready formed in the plant. Indigo is produced during fermentation from Indocan, a yellow and amorphous agent that exists in the plant.
OU:	Very well known and highly important dye of a shade of blue.

2.24 BUI.

Isodon surgosus	Bui.
PHC1:	Earache, itching of skin.

2.25 AKHOR.

Juglans regia,	Walnut (Akhor).
PHC1:	Dandasa for teeth. Used as teeth cure and for swollen gums.
PHC2:	Bark and leaves have alternate laxative, astringent, anthelmintic,

	vermifuge, destroying or expelling intestinal worms) and detergent properties. Bark dried and powdered useful purgative. Juice of green husks, boiled with honey, is a good gargle for sore mouth, inflamed throat.
OU:	Fruit kernel eaten and exported, wood used for furniture, woodcarving and gunstocks.

2.26 BAY NAR NATHA.

Juniper communis	Juniper (Bay Nar Natha).
PHC1:	Diuretic, stomachic (stimulates function of the stomach), carminative, stimulant, flatulence, and diseases of kidney and bladder. Disinfectant for Pus.
PHC2:	Bedsores, Herpes Simplex sores, warts, other excrescences, condyloma acuminatum (anal or genital wart). Cardiac and hepatic (relating to the liver) dropsy.
OU:	Joints pain, cough/ chest pain. Preserves meat, Berries roasted and ground used as coffee. European use as aqueous extract - Roab or Rob of Juniper. Crush berries, macerate with water - distill with water, residue is still evaporated to soft consistence, used for gin. Spirit of Juniper, like oil of turpentine.

2.27 MAMAIKH.

Paeonia emodi	Himalayan Peony (Mamaikh). Paeonia officinalis (Udsalib) is closely related to this plant. It is imported and sold at Rs. 250.00 per Kg. The medicinal value of P. emodi is higher than P. officinalis. Being unaware of this we are using the imported variety and neglecting our own variety.
PHC1:	Rheumatic pains, General and Cardiac tonic. Anti spasmodic, tonic.

	Roots have been employed successfully in convulsions and spasmodic nervous affections such as epilepsy, etc.
PHC2:	Treatment for Backaches. Infusion (prepared by steeping the plant material in water) of roots found effective for obstructions of the liver and complaints arising from the obstruction.
AHC:	Tonic, anti-pyretic and flatulence.
C:	Extremely hardy and will grow in almost any soil. Best in deep rich loam. New plants are left in their beds for two years and transplanted in September.
P:	Pieces of Rhizome taking care to preserve a bud upon the crown of each offset. Can be propagated by seed sown in Autumn, soon after they are ripe, upon a bed of light soil, cover with 0.5 inches of soil. Water well in dry weather and keep free of weeds.
RP:	Cultivation as a crop under shade.

2.28 CHAMCHIPATRA.

Plantago major	Plantain Common (Chamchi Patra).
PHC1:	Stomachic, refrigerant, diuretic, deobstruent and somewhat astringent.
PHC2:	Inflammation of skin, malignant ulcers, intermittent fever. Vulnerary, externally as a stimulant application to sores.
AHC:	Hoof diseases.
Proc:	Dried seed whole or powdered used for stomach pain or digestion. Crushed whole plant, juice extract dropped onto bleeding hoof and then crushed plant tied onto the hoof till cured.
OU:	Seed relished by birds.

2.29 BANKAKRI.

Podophyllum emodi[1]	Indian Mandrake (Bankakri). A pharmaceutical firm exploited the locally available variety *Podophyllum hexandrum* found in Swat

1 A Modern Herbal, Mrs. M. Grieve, Dover Books, 1971.

	District. They established a research station and collected the rootstock. These were then shifted to their own Country and no benefit accrued to the former host environment. With increased awareness such situations can be avoided by sustainable exploitation of our own resources with resultant benefits to the locals.[2]
PHC1:	A gastro-intestinal irritant, a powerful hepatic and intestinal stimulant. Podophylum is a powerful medicine exercising an influence on every part of the system, stimulating the glands to healthy action. It is highly valuable in dropsy, biliousness, dyspepsia, liver and other actions
PHC2:	Acts admirably upon all secretions, removing obstructions and producing a healthy condition of all organs in the body. In smaller doses it is a valuable remedy in skin diseases.
Proc:	It may be given either as an infusion, tincture (prepared in alcohol base) or substance but it is not to be given warm. In large doses it produces nausea, vomiting and even inflammation of the stomach and intestines. Its most beneficial action is when it is given in small doses.
C:	Grows in warm, sheltered spots, such as partially shaded borders and woods. It flourishes on a light, loamy soil. Requires no culture except being kept free of weeds. It is seldom injured by frost.
P:	It is propagated by sowing seeds in sandy soil and planted in the following spring. Or by division of roots, here it propagates extremely fast by its creeping roots. Divide either in Autumn when leaves decay or in spring.
OU:	The Indian variety is about twice as strong as the American Mandrake. It is not identical with nor should it be substituted for the American Mandrake.

2.30 MASLOON.

Polygonum amplexicaule.	Knotgrass (Masloon).
PHC1:	Highly astringent. Joint pain, colic, in combination with other plants. A famous syrup called Sherbat Anjibar is used for fever, menstruation and leucorrhoea.
PHC2:	Diarrhea, gargle, remedy for inflammatory diseases of the tissues.
AHC:	Anti-lice, dyspepsia, and vermifuge.
P:	By pieces of rhizome.
RP:	Cultivation.

2.31 ARIND.

Ricinus communis	Castor Bean (Arind).
PHC1:	Stomachic, removes constipation. Intestinal stimulant, removes obstructions. External use for cutaneous complaints - ringworm and itching. Valuable laxative.

2 Proceeding, Ethnobotany and its Application to Conservation, PARC, WWF, ICIMOD, 1996.

PHC2:	Acts against intoxication.
OU:	Fruit contains Taxol. Highly valued in Mobile Oil and Aviation Industry. Leather dressing and manufacture of artificial leather. Used in dying of cotton textures. Artificial rubber, transparent soap and polishing of high-class furniture. Excellent solvent. Oil extracted by expression or decoction. Heat method of oil extraction produces 5 gallons of oil from 50 Kg. seed.

2.32 JHAL.

ROSE (*Rosa* species)

Plant: shrub, hardy to 10° (except *R. rugosa*, to 30°)
Height: to 6 feet
Soil: moderately rich, moist
Exposure: sun
Propagation: cuttings
Uses: fragrance

Rosa muscatta	Musk Rose (Jhal).
PHC1:	Stomachic, constipation and stomach pains.
OU:	Weak Attar (Otto).
Proc:	Flower boiled in water.
C:	Grown chiefly as hedges between fields of *Rosa damascena*.

SORREL (*Rumex* species)

Plant: perennial, hardy to —30°
Height: 2-3 feet
Soil: rich
Exposure: sun
Propagation: seeds, division
Uses: culinary

2.33 HULA.

Rumex nepalensis	Mountain Sorrel (Hula).
PHC1:	Diuretic, antiscorbutic, diaphoretic, refrigerant action. To allay high fever and quench resultant thirst.
PHC2:	Catarrh, hemorrhages, urinary and kidney disorders, mouth ulcers. To heal wounds and staunch flow of blood. Reduces swelling and inflammation.
C:	Woods and shady places. Planted in moist shady borders. Will thrive if

	kept free of weeds.
OU:	Contains special salt, binoxalate of potash.

2.34 CHITA HULA.

Senecio saligna	Mountain Groundsel (Chita Hula).
PHC1:	Diaphoretic, antisclerotic (prevents hardening of tissue), purgative (stimulates evacuation of bowels), diuretic and anthelmintic. Astringent, wash in burns, inflammation of eyes, sores, cancerous ulcers, rheumatism, sciatica and gout.
PHC2:	Constipation, wounds, worms, and backache snake bite. Sickness of stomach. Weak infusion is a purgative. Strong infusion is emetic.
AHC:	Fodder for goats.
Proc:	Juice extracted from leaves by crushing.

2.35 NER.

Skimmia laureola.	(Ner).
PHC1:	Liver and digestive system, fever.
PHC2:	Skin diseases, headaches.
Proc:	Leaves crushed and mixed in water for liver, digestive system and fever. Smoke used for skin diseases and headache.

2.36 HAND.

Sonchus aspera	Mountain Thistle (Hand).
PHC1:	Fever, constipation, diabetes, Itching and heart problems.
PHC2:	Short of breath, wheezing, Nursing Mothers.
Proc:	Roots and leaves boiled in water for PHC1 and milk extracted from leaves for PHC2. Or 1 cup of warm tea for nursing mothers, 30 minutes before feeding. Herb works best in the form of warm liquid. Contains the bitter alkaloid called cnicin which irritates the mammary glands just enough so that they secrete more milk.
OU:	Cooked as vegetable.

2.37 KATCH MACH.

Solanum miniatum	Black Nightshade (Katch Mach).
PHC1:	Skin diseases, constipation and wounds. Cough as expectorant (promotes the removal of mucus from the respiratory system, diuretic
PHC2:	Heart and liver problems and stomach worms.
Proc:	Decoction for stomach and juice extract for skin.
OU:	Wild variety of Aubergine (Brinjal) and Eggplant. Belongs to Potato, tomato family.

2.38 CHURIATA.

Swertia chirata	(Churiata).
PHC1:	Fever, pneumonia, malaria and typhoid. In liver ailments, promotes secretion of bile

PHC2:	Cures constipation and is useful in dyspepsia. Restores tone after illness.
Proc:	Juice extracted from fresh plant by crushing. Can be boiled in water.
OU:	Contains two valuable bitter tonic (strengthens and enlivens whole or specific parts of the body) principals - Androgropholide and Halmeghin.

2.39 BARMI.

THE ONE-TREE FOREST

Taxus wallichina var baccata	Banyan (Barmi).
PHC1:	Anti-cancer, Tuberculosis.
Proc:	Bark boiled and taken on empty stomach before breakfast. Fruit is also cooked.
RP:	Collection and evaluation of sub-species is very important. Cultivation techniques urgently needed.

2.40 ANJANI.

Ternunalia arjuna	(Anjani).
PHC1:	Diuretic and Tonic for weakness.
PHC2:	Decongestant.

VALERIAN (*Valeriana officinalis*)

Plant: perennial, hardy to —30°

Height: 4 feet

Soil: average

Exposure: sun, partial shade

Propagation: seeds, division

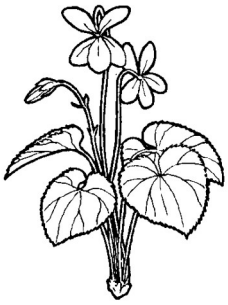
Uses: landscape only

2.41 MUSHIK BALA.

Valeriana wallichii	Valerian Indian (Mushik Bala).
PHC1:	Mild sedative. Stress relief, Antiseptic, cooling effect. Childrens

	nutrition deficiency, digestive. Anti-spasmodic, Leprosy.
PHC2:	Purifies the blood, used to clear pimples, acne. Mouth odors.
OU:	Keeps stored clothes free of insects. Volatile oil used in perfume industry and incense Over 200 tons per year export from Pakistan. Tincture Valeriana Indicae Ammoniata prepared. Contains Valepotriates also called magic fingers to massage tight nerves. Also contains Valerianic and other organic acids.
Proc:	Dried rhizomes and roots used. Tea can be made by steeping 1.5 tablespoons of dried root in 1 pint of boiling water.
C:	Perennial Herb grows in higher elevations on moist slopes, under bushes/ trees.
RP:	Cultivation under shade.

VIOLETS (*Viola* species)



Plant: perennial, hardy to —20°

Height: 6-12 inches

Soil: moist, rich

Exposure: sun to shade

Propagation: seeds, division

Uses: fragrance, landscape

2.42 SUAR PHUL.

Viola canina	Violet (Suar Phul).
PHC1:	Cathartic (purges the body, usually the intestine and cleanses the system) and emetic (induces vomiting). Cough, cold and migraine.
Proc:	Dried leaves and flowers boiled in water.

2.43 MUSHKANA.

Nepeta laevigata	Ground Ivy (Mushkana).
PHC1:	Stomachic, acidity of stomach and digestive.
PHC2:	Coughs and nervous headache. Useful in pulmonary complaints. Tonic for kidneys.
OU:	Cooked as vegetable.
Proc:	Fresh or dried leaves boiled in water. Also cooked as vegetable.

2.44 PATIS.

	Pakistani Atis (Patis).
PHC1:	Stomachic and digestive. Coughs and fever.

2.45 IT SIT.

	(It Sit).

PHC1:	Diuretic, Decongestant and relieves constipation.
PHC2:	Emetic, used for jaundice. Snakebite.
Proc:	Juice extract mixed with milk.

3. OTHER HERBS:

3.1 RAT MUNDIA.

Ranunculus laetus	(Rat mundia).
OU:	Used as fodder.

3.2 SHILEI.

Sarcococca saligna	(Shilei).
OU:	Used for making brooms.

4. WILD VEGETABLES:[1]

4.1 KUNJI.

Dryopteris stewartii (Kunji).	Quite common and is available in many parts of the Galliyat. The young leaves of this plant are collected and cooked as vegetables. This wild vegetable is collected from the forest from April to May.

4.2 KANDHOR.

Dryopteris blandfordia(Kandhor).	This plant is rare and found only in a few selected sites. Young and tender, fresh leaves are used for cooking as a vegetable. Mid May to end June is the collection time for this wild vegetable.

4.3 MUSHKANA.

Nepeta laevigata Ground Ivy (Mushkana).	The leaves of this plant are cooked as a vegetable. Collection time is April to June. Also has medicinal properties (see2.43 above).

4.4 MIRCHI.

Solanum nigra (Mirchi).	Fresh ;eaves are cooked as a vegetable. These are collected from April to June.

4.5 TANDI.

Dipsacus inermis (Tandi).	Fresh leaves are used as a cooked vegetable. Collection is made from the forests from March to June.

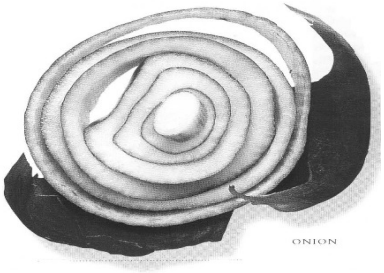
5. POTENTIAL HERBS:

Sr No	Botanical Name	English Name	Local Name

1 People and Plants, Conservation and Training in Applied Ethnobotany, Annual Technical Report, WWF-Pakistan, 1998.

1	*Allium cepa*	Onions	Piaz
2	*Allium sativum*	Garlic	Thomb
3	*Aloe vera,*	Pakistani Aloe	Guar Gandal
4	*Anethum sowa roxb. Ex Flem.*	Dill	Soya
5	*Apium graveolens*	Celery	
6	*Artemisia dracunculus.*	Tarragon	
7	*Atropa belladona*	Nightshade	
8	*Avena sativa*	Oats	Jau
9	*Brassica nigra.*	Mustard	Sarsoon
10	*Brassica oleracea*	Cabbage	Bund Gobi
11	*Brassica oleracea italica*	Broccoli	
12	*Calendula officinalis*	Marigold	Gainda
13	*Capsicum annum var. annum*	Bell Pepper	Shimla Mirch
14	*Carum copticum*	Ajowan	Ajwain
15	*Carum petroselinum var. crispum*.	Parsley	Ajmood
16	Citrus limon	Lemon	Limoo
17	Citrus sinensis	Oranges	Malta
18	Crocus sativus	Saffron	Kesar
19	Cucumis sativus	Cucumber	Kheera
20	*Cuminum cyminum /Bunium persicum/ Vernonia anthelmintica* Wild.	Cumin/ Vernonia	Sufaid & Kala Zeera
21	*Cupressus sempervirens*	Cyprus	Sarooh
22	Curcurbita maxima	Pumpkin	Petha Kudoo
23	Daucus carota	Carrots	Gajar
24	*Eucalyptus spp.*	Eucalyptus	Gond
25	Foeniculum vulgare	Fennel	Saunf
26	Ficus carica	Figs	Anjeer
27	Fragaria vesca	Strawberry	
28	Hordeum vulgare	Barley	Jowar
29	*Jasminum officinale*	Jasmin	Chambeli
30	*Lactuca sativa*	Lettuce	Salaad
31	*Lavandula vera.*	Lavender	
32	*Malus spp.*	Apples	Saib
33	*Mentha spp.*	Mint	Pudina
34	*Ocimum basilicum*	Basil	Kali Tulsi/ Niazbo
35	*Olea europea:*	Olive	Zaitoon
36	*Origanum vulgare*	Oregano	Sathra
37	*Oryza sativa*	Rice	Chawal
38	*Pelargonium odoratissiumum*	Geranium	
39	*Pimenta racemosa, Pimenta acris*	Bay	Tez Pat
40	*Pimpinella anisum*	Aniseed	
41	Pinus spp.	Chir Pine	Cheer
42	Plantago amplexicaulis	Plantain Ispaghul	Ispaghul
43	*Prunus amygdalmus*	Almonds	Badaam

	Prunus amygdalmus dulcis		
44	Prunus ameniaca	Apricot	Khumani
45	Quercus spp.	Oak	
46	*Raphansus sativus*	Radish	
47	Rosa damascena var. trigintipetala.	Damascus Rose	Ghulab
48	Rosmarinus officinalis	Rosemary	Rusmary
49	*Rubus idaeus*	Raspberry	
50	Satureja hortensis	Savory	
51	Salvia officinalis	Sage	Salvia
52	*Sesamum indicum*	Sesame Seed	Till
53	Thymus vulgaris	Thyme	Ban Ajwain
54	*Vitis vinifera*	Grapes	Angoor
55	*Zea mays*	Corn	Makai



5.1 ONION.

Allium cepa	Onions (Piaz) contain small amounts of vitamin A and B. They also

	contain some potassium and sugars.
PHC1:	Antiseptic, antispasmodic, expectorant and diuretic. Crushed Onions used as a compress to disinfect wounds.
PHC2:	Coughs, colds, lowering blood pressure. Recommended for gastric infections and give some protection against cancer. Onion poultices used to treat bronchitis and helps in treatment of acne and boils.
OU:	Culinary uses.
C:	Can be grown as a winter crop if suitable varieties are developed.

5.2 GARLIC.

Allium sativum	Garlic (Thomb) contains vitamin C, thiamine and potassium. Garlic is an antioxidant.
PHC1:	Antiseptic, antibiotic and antifungal. Prevents disease of circulatory system, supportive remedy in high blood pressure, high cholesterol and hardening of the arteries. Used on a regular basis it reduces the need of anti-biotics.
PHC2:	Bronchitis, lung infections, sinusitis and intestinal worms. Helpful in allergic asthma and hay fever if infused oil is used as a chest rub. Fresh juice used as an application to fungal infections.

5.3 GUAR GAND*A*

Aloe vera,	Pakistani Aloe (Guar Gandal)[1]. This is a succulent plant of the Lilly family. It is perennial, caespitose herb, and glabrous underbrush with thick, fleshy and large basal leaves.

PHC1:	Helps to heal skin damaged by radiation, fire or caustic or boiling materials.
PHC2:	Safest and best warm and stimulating purgative. Also for bedsores and hemorrhoids. Irritable bowel syndrome. Fresh juice is cathartic. Given in rectal fissures and piles. Root is given in colic.
AHC:	Purgative for horses.
OU:	Root exudates of potential use for nematode control. Sweelam (1989) has compared it with fenamiphos for the control of Meloidogyne javanica (nematode) for reduction of nematode populations and reduction in egg masses. Can also be used for gully plugging. Has anti bacterial and antifungal properties.

5.4 DILL.

DILL (*Anethum graveolens*)

Plant: annual

Height: 3-4 feet

Soil: average, well drained

Exposure: sun

Propagation: seeds

Uses: culinary

Anethum sowa roxb. Ex Flem.	Dill (Soya). A. sowa is a native Indian variety. The fresh herb is used widely in Asia and in Scandinavia, Germany and Eastern Europe as a flavoring for many food items. Around 330 tons, valued at Rs.12.00 per Kg., were exported from Pakistan in 1991-92.[1]
PHC1:	Seed oil is carminative, stomachic and stimulant. It is recommended for digestive problems.
OU:	Used in preparing fish, chicken, lamb, stews, sauces, salad dressings and breads.
Proc:	Use leaves fresh or dried, picked just as flowers are opening.
C:	The plant is an annual and grows to 3 - 4 feet. It likes an exposure to sun and grows on average but well drained soil. Harvest seeds when they ripen and before they fall upon the ground. Seed 4 to 5 kgs. per acre. Fine seed bed.
P:	By seeds sown in spring.

1 Proceedings, Ethnobotany and its Application to Conservation, PARC, WWF, ICIMOD, 1996.

1 Export Promotion Bureau of Pakistan.

5.5 CELERY.

Apium graveolens	Celery contains substantial amounts of potassium, chlorides and sodium.
PHC1:	Antispasmodic, helps reduce high pressure and gas in the intestinal tract.
PHC2:	Seeds used for treating Arthritis and Rheumatism. Also used as an antioxidant. Juice recommended as a digestive after meals.
OU:	Important high cost vegetable to meet growing demand of expatriate customers in nearby Islamabad market.

TARRAGON (*Artemisia dracunculus*)

Plant: perennial, hardy to —10°

Height: 1-2 feet

Soil: moderately rich, well drained

Exposure: sun, partial shade

Propagation: division, root cuttings

Uses: culinary

5.6 TARRAGON.

Artemisia dracunculus.	Tarragon. Dried leaves and flowering tops constitute Tarragon. It has an unusual and intriguing flavor. The herb is used for flavoring vinegar, pickles, prepared mustard and other food items. About 150 tons were imported into France, Germany, U.K. and the Netherlands in 1991. Price in 1994 was US$ 14,000.00 per ton (Rs. 840.00 per Kg.). Tarragon is thus the most expensive herb.
PHC1:	Aperient, stomachic, stimulant and febrifuge properties.

C:	Loves warmth and sunshine and succeeds best in warm and somewhat dry conditions. A little protection should be afforded to the roots in winter as severe frosts are liable to damage them. Needs a dry and rather poor soil as wet soils will kill them in our winters. A few roots should be picked and placed in hot houses over winter. Only small quantities are needed to maintain a succession.
P:	Division of roots in March or April, or by cuttings struck when growth is commencing in spring.

5.7 BELLADONA.

Atropa belladona	Nightshade is a deadly poison but is used extensively in the Homeopathic trade. It grows wild in neighboring Kaghan of Mansherra District and can be cultivated in the Nathiagalli area of Abbottabad District.
PHC1:	Headache, sore throat, earache and sunstroke.
PHC2:	Used for robust people and children who suddenly fall ill.
OU:	Can be grown commercially under controlled and safe conditions. Needs expert handling.

5.8 OATS.

Avena sativa	Oats are high in carbohydrates and are a good source of vitamin B (thiamine and pantothenic acid), iron, phosphorus and potassium.
PHC1:	Laxative properties and good tonic for heart, uterus, nervous system and thymus gland.
PHC2:	Some protection against cancer of the bowel. Lowers cholesterol in the blood and helps prevent heart disease. Gentle, effective tonic for the nerves.
OU:	Has a market as a cereal and is used to feed horses and mules.

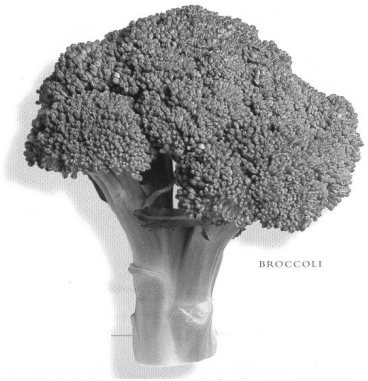
5.9 MUSTARD.

Brassica nigra.	Mustard (Sarson)
PHC1:	Diuretic and antibiotic. Plasters and poultices effective treatment for chest infections. Relieves arthritic joints, chilblains and skin eruptions.
PHC2:	Expectorant, powder mixed with water is a powerful emetic.
OU:	Eaten like spinach. Oil used for hair.

5.10 CABBAGE.

Brassica oleracea	Cabbage (Bund Gobi) contains high amounts of vitamins A and C.
PHC1:	Contains phytochemicals that are effective in preventing cancer. Cabbage juice is valuable for gastric ulcers, bronchial infections and hoarseness.
PHC2:	Cabbage poultice is helpful for boils, bruises and swelling. Warm compress relieves headaches, rheumatic pains, neuralgia and eczema.
OU:	Valuable as a vegetable, can be grown in off-season in relation to down country market.

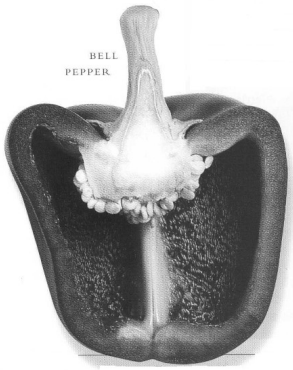
5.11 BROCCOLI.



Brassica oleracea italica	Broccoli, like cabbage is an important cancer prevention food-item. It is an excellent source of vitamins A and C and minerals like calcium and potassium. Contains sulforaphanes, which are a part of the phytochemical group. They stimulate certain enzymes, which aid in the removal of carcinogenic molecules in the cells of the body.
PHC1:	Used in the treatment of breast cancer.
OU:	In demand as a high priced vegetable for the expatriate population in Islamabad. Can be grown off-season to the down country market.

5.12 MARIGOLD.

Calendula officinalis	Marigold (Gainda) is used as a tea, lotion, cream and ointment.
PHC1:	Antiseptic and anti-inflammatory. Useful for boils, spots, inflamed wounds, inflamed and painful varicose veins and sore eyes.
PHC2:	Used for painful, lumpy breasts, sore throats, tonsillitis, chronic ear infections, mouth sores and ulcers. Lotion or cream used for itchy skin rashes, grazes, cuts, eczema and fungal infections.
OU:	Ointment or infusion for chapped skin and as a lip balm. Used as a remedy for dry skin in beauty care. Used in garlands and generally in flower industry. Flower petals are a substitute for saffron to color rice dishes.
C:	Easy to grow as field or potted plant.



5.13 BELL PEPPER.

Capsicum annum var. annum	Bell peppers (Shimla Mirich) are an excellent source of vitamin C, also contain small amounts of vitamin A and iron.
PHC1:	Tonic, antiseptic, expectorant and have anesthetic properties
PHC2:	Treatment of varicose veins, asthma and digestive complaints. Reduces sensitivity to pain by irritating the tissues and increasing blood supply to the affected area and thereby effectively numbing the pain. Eliminates toxins from the body.
OU:	Is a valuable cash crop and gets to the market well in time for a good price.

5.14 AJWAIN.

Carum copticum	Ajowan (Ajwain).
PHC1:	Stomachic and carminative, as a spirituous solution is used as a nasal spray for laryngitis and bronchial infection.
PHC2:	Cure for drug addiction. Astringent, stimulant, as a vermifuge to expel miner worm and used in the manufacture of disinfectant soap.
AHC:	Carminative, stomachic, stimulant, increases lactation.
C:	Fine seed bed preparation, 2.5 to 3 kgs. seed mixed with fine soil due to small size. Seed depth 0.5 to 0.75 inches, row to row 1.5 ft. and inter plant 1 ft.. Water immediately on planting.
P:	By seed, selection is required.
Proc:	Ajwain oil has 40 to 55 % Thymol, a most valuable phenol (antiseptic). Extracted Ajwain oil is treated with a warm solution of sodium hydroxide. This alkali dissolves Thymol. On dilution with hot water the undissolved oils (terpenes etc.) Rise to the surface. The alkaline Thymol compound is decomposed by treatment with hydrochloric acid. Upon cooling the oily layer crystallizes into large, oblique prismatic crystals.
OU:	Thymol is a powerful antiseptic for internal and external use. It is also a deodorant and local anaesthetic. It is extensively used to medicate gauze and wool for surgical dressings. It has a greater germicidal action than Carbolic acid.
RP:	Cultivation as a field crop and reduction of natural seed drop.

PARSLEY (*Petroselinum crispum*)

Plant: biennial

Height: 6-12 inches

Soil: moist, moderately rich

Exposure: shade, partial sun

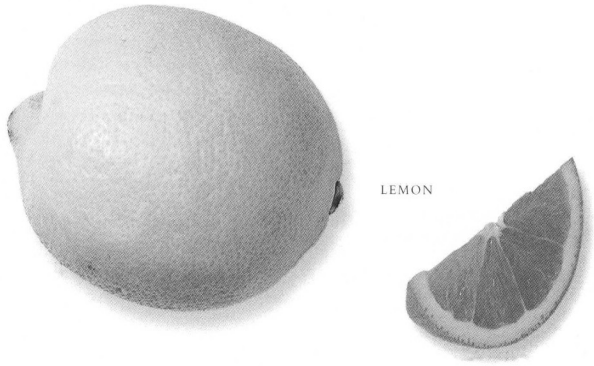
Propagation: seeds

Uses: culinary

5.15 AJMOOD.

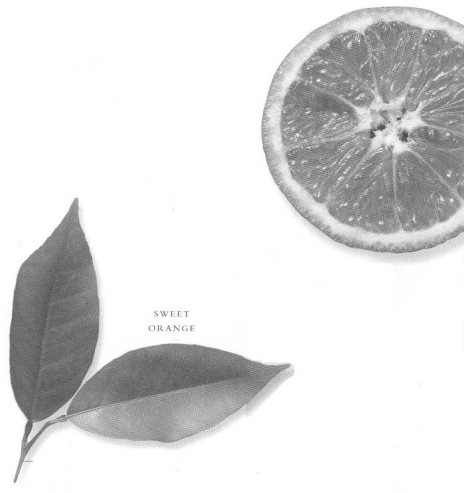
Carum petroselinum var. crispum.	Parsley (Ajmood). This plant, the famous Parsley, has been described above. The herb grows better at higher altitudes and is a cool weather crop. Fresh leaves are used as garnishing and mask even strong culinary odors. The leaves are very rich in Vitamin c and are used to make a sort of tea. The fresh leaves are also a good source of iron,

	calcium and carotene. About 650 to 750 tons were imported into France, Germany, U.K. and the Netherlands in 1991. Parsley fetched US$ 4,000.00 to 4,500.00 per ton (Rs. 240.00 to Rs.270.00 per Kg.).



5.16 LEMON.

Citrus limon	Lemons (Limoo) are rich in vitamin C and contain good amounts of vitamins B and minerals like potassium and calcium.
PHC1:	Antiseptic, astringent, diuretic, insecticidal and tonic. Lemon juice with hot or warm water is used as a liver tonic and is effective against stomach acidity. Strengthens immune system and helps relieve cold and flu. As a massage oil helps rheumatism, arthritis and poor circulation.
PHC2:	Useful in treating hemorrhoids, kidney stones and varicose veins.
OU:	Used as a flavoring, cosmetic and stain remover. Valuable in the market in fresh or pickled form.



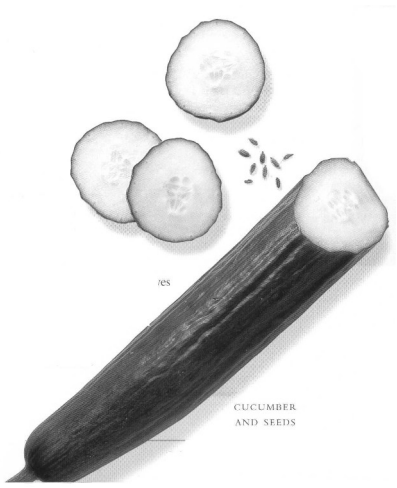
5.17 ORANGE.

Citrus sinensis	Oranges (Malta) are an excellent source of vitamin C.
PHC1:	Helps boost the bodys immune system. Mild sedative, febrifuge, antispasmodic, anti depressant and stomachic.
PHC2:	Essential oil massaged over the stomach is good for constipation and

	flatulence. It strengthens the muscles. Orange is a known as regulator of the digestive system, helps to enhance a diet to loose weight and can reduce cellulite.
OU:	A good fruit and juice that is widely used.
C:	Widely grown in Hazara Division, merely needs Zinc in addition to compost, NPK and good cultural practices like drip irrigation and pruning to thrive.

5.18 SAFFRON.

Crocus sativus	Saffron (Kesar) is grown in Kashmir, among other Countries, and is the worlds most costly spice.
PHC1:	Digestive and stimulant
OU:	Expensive food tinting and flavoring.



5.19 CUCUMBER.

Cucumis sativus	Cucumber (Kheera). Source of vitamin C and small amounts of iron and potassium.
PHC1:	Juice used to soothe irritable bladders and cystitis. Tonic for the kidneys.
PHC2:	Ground seeds effective cure for tapeworms.
OU:	Valuable vegetable and pickle.

5.20 CUMIN.

Cuminum cyminum and *Bunium persicum*	White and black Cumin (Zeera). Rhizomatous herb/ under-shrub. Contains carbohydrates, protien, vitamins A, B1, B2, and C. Also sodium, phosphorus, potassium, calcium, iron and zinc.
PHC1:	Carminative and laxative.
PHC2:	Food flavoring, eyewash, astringent and stimulant.
AHC:	Stimulant, eyewash and carminative.
OU:	Valuable culinary spice.

C:	Fine seed bed preparation, 2.5 to 3 kgs. seed, row to row 1.5 ft. to 2 ft., inter plant 9 inches. Sown in Aug or Sept, flowers in Nov, harvest in Dec. Summer crop sown in Feb harvest in June. 150 to 160 Kgs./ acre.
P:	By seed and rhizomes. Seed propagated plants are harvested in 3 years while rhizome propagated plants require 2 years before harvest is possible.
RP:	Cultivation as a field crop and prevention of natural seed shedding.

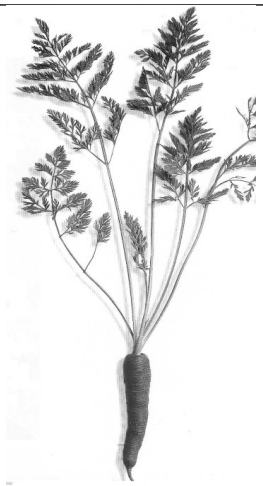
5.21 CYPRUS.

Cupressus sempervirens	Cyprus (Sarooh) is a stately and elegant tree used in formal Persian Gardens and also informally. It is plentiful all over Pakistan. Its medicinal properties are little known and is thus much over looked. Its oil is one of the safest to use.
PHC1:	Antirheumatic, antispasmodic, astringent, diuretic, menopausal, detoxifying and used in problems of the circulatory system (varicose veins)
PHC2:	Used effectively in treating hay fever, asthma, coughs and bronchitis. When used as a massage oil, in steam inhalations or burnt in a room has soothing action on the nervous system and helps relieve tension and stress.

5.22 PUMPKIN.

Curcurbita maxima	Pumpkin (Petha Kadu) seeds are rich in protein and unsaturated vegetable oils. Supply vitamins E and B. Contain zinc and iron.
PHC1:	Diuretic and used in diet to prevent cancer. Zinc in the seeds beneficial

	to treatment of prostrate problems.
PHC2:	Helps to expel intestinal worms. Seeds are soothing to irritated tissues.



5.23 CARROTS.

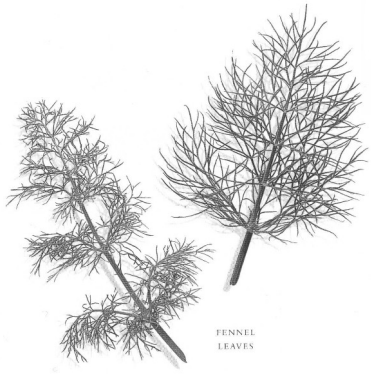
Daucus carota	Carrots (Gajar) are an excellent source of beta-carotene, which is converted by the body into vitamin A. Also aids in prevention of cancer.
PHC1:	Diuretic, leaf tea used for chronic cystitis, kidney stones and gout. Whole carrots excellent for cure of night blindness.
PHC2:	Helpful in prevention of cataracts, beneficial effect on respiratory and circulatory system.
OU:	Sold as a vegetable.

5.24 EUCALYPTUS.

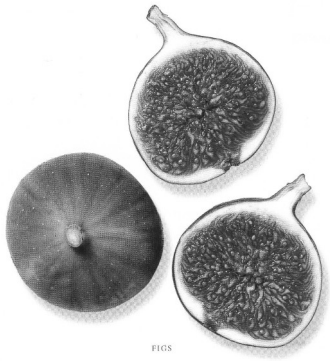
Eucalyptus spp.	Eucalyptus (Gond) oil is one of the most important oils. Much maligned in recent years it never the less is an important source for

	fire, paper and match wood.
PHC1:	Antiseptic, antirheumatic, antineuralgic, vermifuge, febrifuge and balsamic expectorant. Very antiseptic oil used as an inhalation for pneumonia, bronchitis, asthma, colds, flu, mucous congestion, sinusitis and tuberculosis.
PHC2:	Helpful in treatment of skin infections and herpes.

5.25 FENNEL.



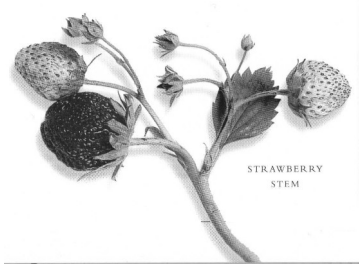
Foeniculum vulgare	Fennel (Saunf) is an aromatic herb with culinary, cosmetic and medicinal uses. About 150 tons, valued at Rs.1000.00 per ton, were exported from Pakistan in 1991-92.[1]
PHC1:	Carminative, diuretic, antispasmodic, clears flatulence and promotes milk flowing in nursing mothers.
PHC2:	Helpful for arthritis and water retention. Tea makes good eyewash for conjunctivitis. Improves the function of the liver.
C:	Up to 6000 ft. 4 to 5 kgs. seed in light broadcast.
OU:	Oil used in manufacture of toothpaste, soap and gripewater.



5.26 FIGS.

Ficus carica	Figs (Anjeer) have high amounts of sugars and fiber. They are an excellent source of iron, potassium and calcium.
PHC1:	Recommended for constipation, hemorrhoids, abscesses and chilblains.
PHC2:	Relieve chest complaints, treatment for colds and throat infections.
OU:	Sold as dried fruit.

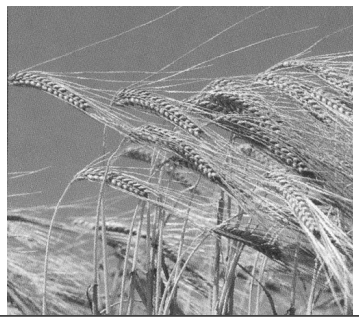
1 Export Promotion Bureau of Pakistan.



5.27 STRAWBERRY.

Fragaria vesca	Strawberry is rich in vitamin C, good source of fiber, iron and potassium.
PHC1:	Astringent, good for digestive system and recommended for treating high blood pressure. Helpful in removing kidney stones.
PHC2:	Juice removes skin blemishes and useful in treating sunburn.
OU:	Sold fresh as valuable fruit and processed to make jam.

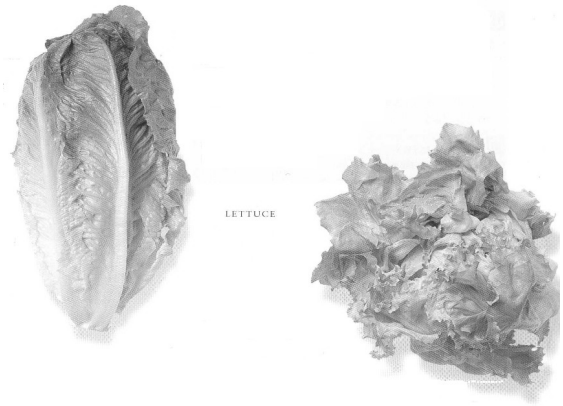
5.28 BARLEY.



Hordeum vulgare	Barley (Jowar) is a source of vitamin B9 (folic acid), potassium, phosphorus, magnesium, iron and calcium.
PHC1:	Promotes normal functioning of the heart and stabilizes blood pressure.
PHC2:	Reduces acid in the spleen and eases vomiting. Soups helpful in diarrhea, constipation and flatulence.
OU:	Important cereal, food for humans and animals.

5.29 CHAMBELI.

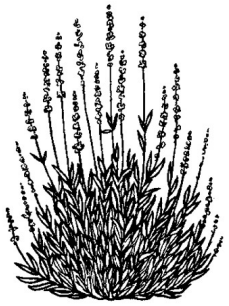
Jasminum officinale	Jasmin (Chambeli). The common white jasmine of North India. It is the official flower of Pakistan
PHC1:	Antidepressant, treats PMS and other female complaints, uterine tonic and anticatarrhal.
PHC2:	Coughs, hoarseness and disorders of the breast.
OU:	It exudes a delicate, sweet odor and is highly valued.
C:	It grows to heights of 12 to 20 feet. The stem is feeble and needs support. When grafted with *J. grandiflora* it grows to an erect bush 3 feet high. This is the Jasmin of the perfume trade. It is planted in rows exposed to the sun and well sheltered from North winds. It is damaged by frosts and needs protection in our winters. It blooms in 2 years after grafting. Blooms from June to October. The blooms in August and September are the most odoriferous. The bush is pruned in Autumn.
Proc:	One acre can yield 250 Kg of perfume extract. Oil is extracted by enfleurage or absorption by a fatty body like olive oil. Square glass trays, framed in wood and 3 inches deep are used. They are spread over with grease to 0.5 inches thickness and ridged to facilitate absorption. Freshly gathered flowers are sprinkled and renewed every morning. Trays are piled in stacks to prevent evaporation of aroma. The pomade is scrapped off the glass, melted at low temperatures and strained. About 1.5 Kgs of flowers to half Kg of grease is used. It is then macerated in 1-pint rectified spirit to form the extract called Huile antique au jasmine and fetches a high price.



5.30 LETTUCE.

Lactuca sativa	Lettuce (Salaad) contains vitamins A, C, B9 (folic acid) and potassium, iron, copper and calcium.
PHC1:	Beneficial as part of cancer prevention diet. Calming effect upon the nervous system.
PHC2:	Prescribed for palpitations and curbs excessive libido. Leaves used as poultice for swollen joints and bruises.
OU:	Sold fresh as a salad.

LAVENDER (*Lavandula* species)



Plant: perennial, hardy to 0° (except *L. dentata*, to 15°)

Height: 1½-4 feet

Soil: dry, well drained

Exposure: sun

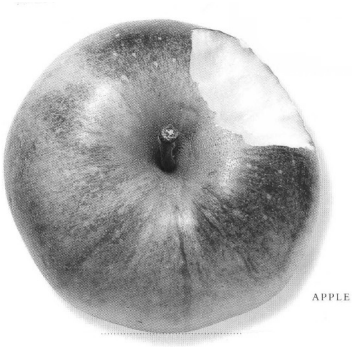
Propagation: seeds, cuttings

Uses: fragrance

5.31 LAVENDER.

Lavandula vera.	Lavender is a shrubby plant indigenous to the mountainous regions of the Countries bordering the Western half of the Mediterranean. Its fragrant oil is a very valuable article of commerce and is used extensively in the perfume industry. The essential oil is produced from the flowers and flower stalks. Lavender is also sold fresh as bunched Lavender and as dried Lavender. The flowers are used powdered for sachet making and also for pot-pouri. Thus the plant is very valuable. L. vera is a narrow leafed variety and grows to 1 foot to 3 feet in height. L. vera produces an oil high in esters.
PHC1:	Aromatic, carminative and nervine properties. Acts as a stimulant in hysteria, palsy and similar disorders of debility and lack of nerve power.
PHC2:	Mild stimulant, relieves toothache, neuralgia, sprains and rheumatism. Rubbed externally for paralyzed limbs.
C:	Lavender is fairly easy to cultivate on friable, garden soil. It is best grown on light soil – sand or gravel – in a dry, open and sunny place. Windbreaks are essential as the tall flower spikes can break away from their junction with the stem. Frost can also injure the plant. Thus some form of protection is required in extreme weather. Careful preparation of land is required for commercial cultivation. The land should first be cleaned of weeds in the Autumn. These weeds should be burnt and their ashes along with wood ashes should be scattered over the land. The land should then be left fallow till the following spring. Once again all weeds should be cleared as before. The land is then plowed over. During late spring the plants are dibbed in. Rows should run from North to South. The distance between rows is recommended at 2 feet with 1 foot between plants. Young plants are prevented from flowering in the first year by clipping. Full pickings are obtained from the second to the fifth year. After the third year the bushes are pruned in March. Five years is considered optimum for flower production on commercial scale. Thus for long term plantations only one fifth of total available land is planted each year. Thus five-year cycles of fresh

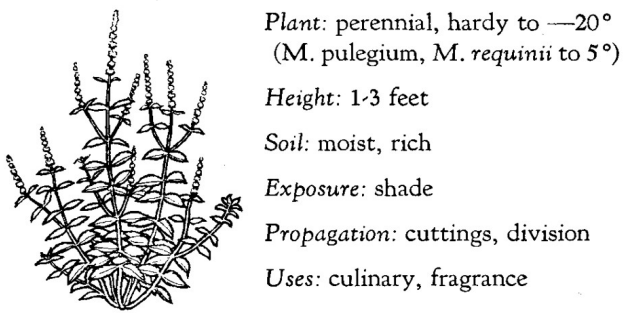
	plants are maintained every year.
P:	Plants may be grown from seed, sown in April. However, most plants are grown from cuttings and layering.



5.32 APPLE.

Malus spp.	Apples (Saib) are an excellent source of fiber, vitamins, amino acids and minerals. They have a higher proportion of phosphates than any other fruit or vegetable.
PHC1:	Used as treatment for rheumatism, mental and physical fatigue and hoarse throats.
PHC2:	Useful in treating urine retention and combat high levels of cholesterol.
OU:	Sold fresh as fruit and processed to make jams and preserves.

5.33 PUDINA.



Mentha spp.	Mint (Pudina). Pakistan hosts 8 species of this family. Mint leaves are among the most important of the Worlds herbs. The Worlds demand for peppermint oil and menthol is met from the following three species which are also recognized by the International Organization for Standardization. *M. arvensis Linn var. Piperascens malinvaud.* *M. piperita Linn var. piperita.* *M. spicata Linn. Syn: M. virides Linn.* Peppermint and spearmint are cultivated commercially. The essential

	oils extracted from various members of the genus Mentha satisfy the largest part of World demand for mint flavoring. The aromatic leaves of spearmint and peppermint are widely used in flavoring and medicinal purposes. Spearmint is the variety most used for culinary purposes. Peppermint is more suitable as a flavoring agent and is widely employed for medicinal purposes. It is also used in the preparation of mint tea, the most extensively consumed of herb teas. The major uses of mint oils are as aromatic agents in toothpaste, mouthwashes and chewing gums. Mint was priced wholesale , in 1991, as over US$ 2,500.00 per ton (Rs.150.00 per Kg). Over two thousand tons were imported into France, Germany, U.K. and the Netherlands in 1994. Pakistans consumption of Peppermint oil was 10 tons and of Menthol 25 tons in 1987 according to a study carried out by the A.D.B.P.
M. piperita.	
PHC1:	Carminative, flavoring agent, stomachic and antiseptic. Used for flatulence and colic. It is widely used in cholera and diarrhea.
PHC2:	Anti-spasmodic, relieves pain arising from the alimentary canal. Allays sickness and nausea. Used as an infants cordial.
AHC:	Antiseptic, carminative, stimulant and anti-pyretic.
C:	M. piperita grows to 3 feet in height, M. spicata will grow to 1.5 feet height. Most mints grow anywhere except in direct hot sun. They do best in light, moderately rich soils that is moist and in shade or partial shade. These herbs spread rapidly by underground stems and runners. Flowers should be kept pinched back to ensure bushy growth. Indoor or protected growth is essential in winter and flourishes. Commercial cultivation of peppermint is only possible in the same field for two years. There are two varieties known commonly as white and black. The black variety is hardier and produces more oil. However, the white variety produces an oil of superior quality and fetches greater price. The oil of the white variety is also used in the manufacture of explosives. Unfortunately for Abbottabad, it is easily destroyed by frost. However, protected environments can easily overcome this problem. A balanced NPK fertilizer consisting of 40 Kg. N, 20 Kg. P and 70 Kg. K and plenty of compost will ensure a good commercial crop that is free from Rust fungal attack. Two to three tons per acre of peppermint can be obtained and this yields about 15 Kg of oil. Peppermint requires frequent irrigation. The oil of peppermint is first in importance amongst essential oils. Menthol is its chief constituent.
P:	Can be propagated by layering and division or stem cuttings.
M. spicata.	
PHC1:	Stimulant, carminative and antispasmodic, though less powerful than peppermint and is less used for these purposes. It is better adapted for childrens maladies.
PHC2:	Distilled water of spearmint will relieve hiccups and flatulence as well

	as the giddiness of indigestion. The sweetened infusion is an excellent remedy for infantile problems. A homeopathic tincture prepared from the fresh plant in flower is used in gravel and as a local application in hemorrhoids. Its principal employment is for its febrifuge (combats fever) and diuretic virtues.
OU:	Mint jelly, sauce, vinegar punch and cake is used. Fresh sprigs are used to garnish food items.
C:	A moist situation is preferable but will succeed in almost any soil. Should be planted in the coolest and dampest site available. A bed in sunny and one in shaded conditions will supply early and late harvests. Beds are benefited by an annual top dressing of rich soil or compost applied towards the close of Autumn. Winter protection will provide a yield throughout the season. To have really good mint, the plantation should be remade every three years. A good stock should be available to enable forcing. This can be had in greenhouses or protected environments. This is done by inserting a quantity of good roots in boxes of light soil and watering freely. Forcing is necessary from November to March at intervals of three weeks due to early decay of forced roots. Mint should not be restricted to a single bed due to the liability of Rust. This fungus is perennial and destroys any garden that it infests. Healthy stock should be planted in separate beds of uninfected soil. Commercially on large scales mint can yield 4 to 5 tons per acre.
P:	Spreads by underground runners and creeping stems. Should be planted by lifting roots in March and dividing them. Each piece showing a joint will grow. Plant in shallow trenches, cover with 2 inches of soil. Plant 6 inches apart with 8 inches between rows. Cuttings in summer or off sets in spring can be used to increase stock.

5.34 NIAZBO/ KALI - **BASIL (*Ocimum basilicum*)**

Plant: annual

Height: 1-2 feet

Soil: moderately rich, moist

Exposure: sun

Propagation: seeds

Uses: culinary

Ocimum basilicum	Basil (Niazbo/ Kali Tulsi). This herb is a native of North West Pakistan and Iran. It is an annual of the Mint family. It is now cultivated in Southern France, other Mediterranean Countries and the U.S. Curly leaf Basis (*var. Differeme Benth)* is considered most suitable for cultivation and is reported to give good yields of high

	quality oil. Sweet Basil possesses a clove-like scent with an aromatic, somewhat saline taste. Two main varieties of Basil are traded; sweet or common Basil (*Ocimum basilicum*) and bush Basil (*O. Minimum*). Sweet Basil is used as a culinary herb and bush Basil is used for decorative purposes and as an insect repellent. Sweet Basil is widely used in an assortment of culinary dishes. The oil of sweet Basil has a place in certain perfume compounds. Its high cost can be lowered to make its use competitive to the cheaper Reunion oil. The import figures for 1994 indicate over 800 tons imported into France, Germany, U.K. and the Netherlands. Basil fetched over US$ 1,000.00 per ton in 1991 (Rs.60.00 per Kg.).
PHC1:	Stomachic, anthelmintic, alexipharmic, antipyretic, diaphoretic, expectorant, carminative, stimulant and pectoral.
PHC2:	Infusion is given for cephalalgia and gouty joints. Also used as a gargle for foul breath. The juice of the leaves is considered useful in the treatment of croup and is a common remedy for coughs. It has a slightly narcotic effect and allays irritation in the throat. It is used as a nasal douche and as a nostrum for earache and also for ringworm. The plant is also used in homeopathic medicine.
OU:	Root, bark and leaves are cyanogenetic. Alcoholic extracts of leaves and alcoholic and aqueous extracts of flowers posses anti-bacterial activity against Micrococcus pyogenes var. aureus. Seeds possess demulcent, stimulant, diureiaphoretic and cooling properties. They are given internally in cases of habitual constipation and piles. They are used in bowel complaints of children. Flowers are carminative, diuretic, stimulants and demuls. Basil oil possesses insecticidal and insect repellent properties. It is effective against houseflies and mosquitoes. It is also bactericidal.
C:	Sweet basil grows to about 2 feet high and prefers moderately rich and moist soils. Bush basil grows to about 1.5 feet tall. All Basils are annuals and can be grown in full sun or semi-shade and a warm, moderately rich soil. They should not be fertilized as flavor is likely to be sacrificed for lush growth. Water regularly to keep growth succulent and leaves fresh. Indoors, basil requires sun and should be pinched occasionally to keep growth bushy.
P:	Basil grows readily from seeds sown in spring as soon as the soil is warm.

5.35 Zaitoon:

Olea europea:	Olives (Zaitoon). Abbottabad District, like many of the surrounding Districts, hosts the wild variety of the Olive Tree. This is the Kau or Olea cuspidata. Trials in some parts of the Country buy the Federal Ministry for Food, Agriculture and Livestock have proved that successful grafting of viable Olive stock onto its wild variety can yield good fruiting. This circumvents the long wait associated with planting.
PHC1:	Beneficial for hyperacidity by reducing level of gastric secretions. Treatment of constipation and peptic (gastric secretions and area affected by them) ulcers (slow healing sore occurring internally or externally).
PHC2:	Dry skin and hair. Leaves used to treat High Blood Pressure, stress and abrasions of the skin.
OU:	Excellent cooking oil. Fruit eaten as an apéritif. Excellent source of vitamin E.
P:	Budwood is grafted onto the wild Olive in early spring.

OREGANO (*Origanum vulgare*)

Plant: perennial, hardy to —30°

Height: 2-2½ feet

Soil: average, well drained

Exposure: sun

Propagation: seeds, cuttings

Uses: culinary

5.36 SATHRA.

Origanum vulgare	Oregano (Sathra). This fragrant, spicy, warm, pungent and bitter herb is aromatic and camphoraceous. It can be grown in March and April. It is an essential ingredient of chilli powder and is what made pizza famous. It is used for flavoring many food items. It is a perennial (lives more than two years, normally flowering every year) and hardy plant that grows to 2.5 feet. It thrives on average, well-drained soil and likes an exposure to sun. O. onites, (Pot Marjoram) O. marjorana (Sweet or Knotted Marjoram) and O. heracleoticum (Winter Marjoram) the cultivated species are more widely used in cuisine and medicine. Oregano prices stood at US$ 4,500.00 to 4,900.00 per ton in 1991 (Rs.260.00 to Rs. 300.00 per Kg.), about 1,600 to 1,750 tons were imported into France, Germany, U.K. and the Netherlands in 1994.
PHC1:	Carminative, stomachic, diuretic, diaphoretic and emmenagogue properties. Stimulant and tonic in diarrhea and colic.
PHC2:	Chronic rheumatism and toothache. Due to the spasmolytic action of its oil it is used in whooping cough and bronchitis. Homeopathy uses it for the treatment of hysteria.
AHC:	Veterinary liniments.
OU:	Cosmetics and soap industry.
C:	Well-drained sunny and average soil. Requires routine watering. Flowers should be cut back to ensure bushiness. Winter marjoram is hardy enough to survive in the open, in a dry soil and is generally propagated by division of the roots in Autumn. Pot Marjoram is also a hardy perennial. It is generally increased by taking cuttings in early summer, inserted under a hand glass and later planted out in a spacing of 1 foot between rows and nearly as much between plants.
P:	Can be grown from seed or by dividing existing plants. Seed is slow in germinating and quicker when natural Rooting and Fruiting hormones

5.37 RICE.

Oryza sativa	Rice (Chawal) contains high levels of carbohydrates, contributes B vitamins – folic acid and pyridoxine – iron and potassium.
PHC1:	Urinary ailments and stomach upsets. Water from boiled rice used to rehydrate persons suffering from fluid loss through diarrhea.
PHC2:	Abdominal bloating, lack of appetite and indigestion
OU:	Important cereal.

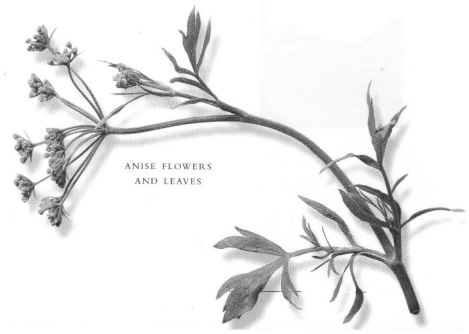
5.38 GERANIUM.

Pelargonium odoratissiumum	Geranium essential oil is used widely in the perfume industry.
PHC1:	Antibacterial, antidepressant, antifungal, anti-inflammatory, anti-infectious, antispasmodic, diuretic, deodorant and useful for treating PMS.
PHC2:	Tonic to the nervous system and helps menopausal problems. Relieves symptoms of constipation, diarrhea, enteritis and mastitis. Helpful in treating skin conditions like eczema, shingles and chilblains.
OU:	Excellent insect repellant. Oil used in perfume industry.

5.39 BAY.

Pimenta racemosa, Pimenta acris	Bay (Tez Pat) sold at $ 4,600.00 per ton (Rs. 275.00 per Kg.) 1994. About 880 tons were imported into France, Germany, U.K. and the Netherlands in 1991.

PHC1:	Antidepressant, antiseptic, aids digestion and regulates the rheumatic system.
PHC2:	General tonic and assists growth of hair and helps develop strength. Good for colds, sinusitis, bronchitis and pneumonia.
OU:	Used as a culinary herb.



5.40 ANISEED.

Pimpinella anisum	About 11 tons of Ansine or Aniseed was exported from Pakistan in 1991-92. It was valued at Rs. 17.27 per Kg.[1]
PHC1:	Helps digestive and respiratory system. Oil used a massage helps muscular system and pains, bronchitis, indigestion and flatulence.
PHC2:	Useful in treatment of mucous cough, asthma and loss of libido.
OU:	Culinary and cosmetic use.

5.41 PINE.

Pinus spp.	The Pine tree (Chir) is found abundantly if the District. It is used in herbalism, homeopathy and aroma therapy.
PHC1:	Antiseptic, anti-infectious, antifungal, antidiabetic, neurotonic, decongestant of the lymphatic system and parasiticide. Treatment of Stubborn skin diseases and healing old wounds.
PHC2:	Pneumonia, bronchitis, asthma, flu, coughs and colds.
OU:	Widely used in perfumery, disinfectants, insecticides and detergents. Used as Resin and Turpentine.

1 Export Promotion Bureau of Pakistan.

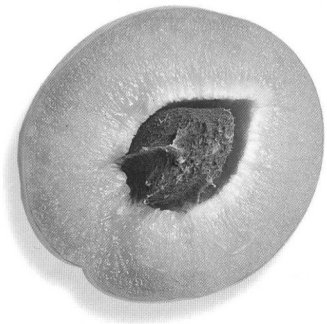
5.42 ISPAGHUL.

Plantago amplexicaulis	Plantain Ispaghul (Ispaghul).
PHC1:	Demulcent in diarrhea and dysentery and other intestinal complaints.
C:	Rainfed crop, fine seed bed, 2 to 2.5 kgs. seed. row to row 1.5 ft. Seed is lightly covered with soil.
PHC2:	Reduces inflamed mucous membranes of the intestinal canal, a mild laxative.
Proc:	Decoction (boiled in water and reduced to make a concentration extract) or seeds mixed with sugar and water. Roasted seeds become astringent and used for childrens diarrhea.

ALMONDS

5.43 ALMONDS.

Prunus amygdalmus Prunus amygdalmus dulcis	Almonds (Badam) contain good amounts of vitamin E, calcium, iron, magnesium, phosphorus and potassium.
PHC1:	Cleansing and moisturizing properties. Known to be good as an intellect stimulant.
OU:	Widely used as culinary and cosmetic product.



APRICOT

5.44 APRICOT.

Prunus ameniaca	Rich natural source of vitamins A and B2, and iron. When dried twice as much vitamin A and ten times the amount of iron becomes chemically available.
PHC1:	Protects and softens the skin and avoids the formation of fine lines in aging skin. Helps prevent bronchitis and asthma.
PHC2:	Warm kernel oil relieves earache.
OU:	Used in cosmetic industry and as dried fruit.

5.45 OAK.

Quercus spp.	Oak is the archetypal decidous tree.
PHC1:	Bark or galls are a strong astringent. Decoction used as a mouthwash for loose or bleeding gums. Oak leaf tea is used for low blood pressure and general weakness.

5.46 RADISH.

Raphansus sativus	Exceptionally good source of vitamin C, contribute B vitamins, iron and potassium.
PHC1:	Antibiotic, diuretic, antifungal and act on the urinary tract. Beneficial in the treatment of indigestion, flatulence and bloating caused by intestinal gasses.
PHC2:	Seeds used to treat bronchitis, raw radishes dispel phlegm and clear

	blocked sinuses.
OU:	Valuable salad vegetable.

5.47 GULAB.

Rosa damascena var. trigintipetala.	T le w T th be w ca th R sk **ROSE (*Rosa* species)** *Plant:* shrub, hardy to 10° (except *R. rugosa*, to 30°) *Height:* to 6 feet *Soil:* moderately rich, moist *Exposure:* sun *Propagation:* cuttings *Uses:* fragrance and has pale green or extracting Rose lowers and leaves. ına (Ibn-e-Sina) in ar) was discovered in India[1]. At the mperor Jehangir a f the sun separated discovered by the ater. The oil was erfume. Persia and Kashmir were the principle exporters in the Ancient World. however, there is no significant export and now the plant is used for extraction and consumption in the local market. The Turks introduced the flower and the extraction to Europe via Bulgaria. Bulgaria was then under Turkish rule. Since that time Bulgaria is the Worlds Center for Attar production followed by France. The R. damascena grown in Bulgaria thrives best in sandy soil, well exposed to the sun, protected from cold winter winds and having perfect drainage. A rose plantation lasts from 8 to 10 years with 10,000 rose trees per acre. One acre of roses fetches 50 Kgs. of flowers every day for three weeks. This averages to about 1,000 Kg. However, weather during flowering greatly effects yields. In cool weather with some rainfall the yield is best and lasts for four to even six weeks. In case of hot, dry weather harvesting lasts for only two weeks. Flowers are picked early in the morning until the temperature rises by about 11.00 am. Flowers are distilled on the same day and about 10,000 Kgs. of roses produce 1 Kg. of oil. This can be increased to 10 Kgs. if the volatile solvent process is adopted. The variety R. centifolia and some crosses of R. damascena have proved to be of use and some are better adapted to vagaries of weather. There is a need of research in this plant and its possible introduction to small farmers in the area.

1 A Modern Herbal, Mrs. M. Grieve, 1931.

ROSEMARY (*Rosmarinus officinalis*)

Plant: perennial, hardy to 0°

Height: 2-6 feet

Soil: dry, poor, well drained

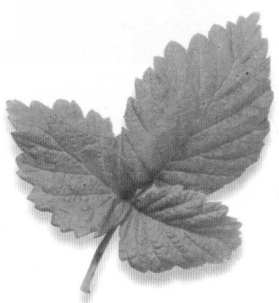
Exposure: sun

Propagation: seeds, cuttings

Uses: culinary

5.48 ROSEMARY.

Rosmarinus officinalis	Rosemary (Rusmary). This exotic, leafy, evergreen shrub grows to 2 m in height. The flowers are an excellent source of honey and impart their characteristic flavor. About 1,000 tons were imported into France, Germany, U.K. and the Netherlands in 1991. The price in 1994 was about US$ 2,800.00 per ton (Rs. 150.00 per Kg.).
PHC1:	Astringent and serves as a nervine tonic. Carminative, diaphoretic, diuretic, aperient, emmenagogue and stomachic.
PHC2:	Infusion with borax is said to cure premature baldness. Useful in atonic dyspepsia. Used for vapor baths for relief of rheumatism, paralysis, gout and incipient catarrhs. Dried leaves smoked for relief of asthma. Decoction of leaves employed as an abortifacient.
OU:	Pressed juice of the leaves possesses a strong anti bacterial action on Staphylococcus aureus, Escherichia coli and Bacillus subtilis. One of the ingredients in Eau-de-Cologne.
C:	Succeeds best in light, rather dry soil and in sheltered positions like the base of a low wall with a south exposure.
P:	Propagated by seeds, cuttings, layers and division of roots. Seeds may be sown upon a warm sunny border. Cuttings taken in August, dibbled into a shady border, two thirds of their length into the ground, under a hand glass will root and be ready for transplanting into permanent quarters the following Autumn. Layering can be readily accomplished in summer by pegging some of the lower branches under a little sandy soil.



RASPBERRY

5.49 RASPBERRY.

Rubus idaeus	Raspberries fruit in summer and is a valuable addition to horticulture and nutrition enhancement.
PHC1:	Astringent, anti-inflammatory and antispasmodic, especially applicable to the womb. Strong leaf tea used for mouthwash for sore mouths, sore throats, weak gums and mouth ulcers.
OU:	Fresh fruit and jams.

SAVORY (*Satureja* species)

Plant: annual and perennial
(*S. montana* hardy to 10°)

Height: 18 inches

Soil: light, well drained

Exposure: sun

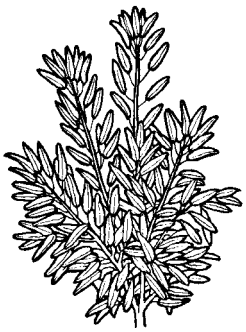
Propagation: seeds, cuttings

Uses: culinary

5.50 SAVORY.

Satureja hortensis	Savory. This erect pubescent annual herb is a native of Kashmir, Its odor is strong, warm and highly aromatic. The leaves are used as a flavoring for many food items.
PHC1:	Carminative, aromatic and stimulating. Considered as a good expectorant.
PHC2:	Sprigs wrapped on wasp or bee stings provide instant relief.
OU:	Gives distinctive flavor to honey, flowers in July.
C:	Thinned to 6 inches apart and well watered. Likes a rich, light soil. Early spring seedlings need topping in June. When the plants flower they may be pulled out for drying for use in winter.
P:	Raised from seed, sown in early April in shallow drills 9 inches or 1 foot apart.

SAGE (*Salvia* species)



Plant: perennial, hardy to —30°
(*S. gracilistyla* hardy to 20°

Height: 2-3 feet

Soil: dry, well drained

Exposure: sun

Propagation: seeds, cuttings

Uses: culinary

5.51 SALVIA.

Salvia officinalis	Sage (Salvia). This is a member of the mint family and is a hardy variable sub-shrub cultivated as a spice and for medicinal purposes. Can stand outdoor wintering. Young plants that have not reached the flowering stage possess the finest aroma and the most oil content. Odor is strong, fragrant and aromatic. Sage is the most popular herb for use in culinary preparations in the West and is used as a flavoring. Fresh leaves are used in salads and sandwiches. Over 1,750 tons were imported into France, Germany, U.K. and the Netherlands in 1991. Price in 1994 was US$ 5,000.00 to 5,500.00 (Rs. 300.00 to Rs.330.00 per Kg.).
PHC1:	Mild tonic, astringent and carminative. Infusion of leaves used for gargling in the treatment of sore throats. A hot infusion is said to be diaphoretic. Extracts of the leaf are said to be antipyretic.
PHC2:	Used in female disorders since ancient times. Dried leaves are used as a fumitory.
OU:	Used in perfumes as a deodorant. Used in insecticidal preparations. Oil is used as a convulsant Sage oil possesses anti oxidizing properties and can be used as an anti oxidizing agent mixed with cotton seed oil to be used as a natural surfactant, carrier, spreader or sticker when using liquid based fertilizers, herbicides and pesticides. Anti oxidants are agents used to prevent or delay oxidation or deterioration, especially with exposure to air. They provide protection against destructive molecules called free radicals. Three vitamins, A, C, E (ACE vitamins), in conjunction with the mineral selenium, are anti oxidants that prevent the formation of free radicals or act as scavengers that mop up these undesirable agents. The surfactant is a stand-alone ovicide. Anti oxidant indices of Sage oil are between 8.8 and 10.0. Seeds contain 18 % protein and yield a drying oil used in the production of oil paints.
C:	Succeeds best in a dry, somewhat warm border. Thrives in a position shaded from direct sun but not under trees. Plantation must be renewed every three to four years as the plant degenerates. Young

	plants should not suffer from want of water in the first summer.
P:	Occasionally by seed but more frequently by cuttings. New plantations can be readily made by pulling off young shoots of 3 - 4 year old plants in spring. Cuttings are inserted a foot apart either way and must be sufficiently hardy to grow and maintain themselves on the moisture in the ground.

SESAME SEEDS

5.52 SESAME SEED.

Sesamum indicum	Sesame seeds (Till) are rich in unsaturated oil, vitamins A, B (thiamine and riboflavin, and E, potassium, magnesium and calcium.
PHC1:	Soothing liver and kidney tonic and act as a mild laxative. Seeds used to treat osteoporosis and stiff joints. Burns, boils and ulcers treated by applying oil.
PHC2:	Strengthens teeth and bones. Leaves recommended as an internal treatment for cystitis, diarrhea and catarrh. Relieves liver and gall bladder problems.
OU:	Culinary purposes.

THYME (*Thymus* species)

Plant: perennial, hardy to —20°

Height: 2-12 inches

Soil: dry, light

Exposure: sun

Propagation: seeds, cuttings

Uses: culinary, ground cover

5.53 BAN AJWAIN.

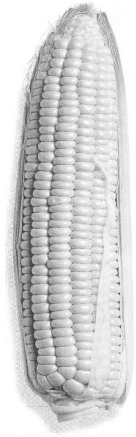
Thymus vulgaris	Thyme (Ban Ajwain). It is a perennial with a woody fibrous root.

	Grows at an altitude of 1525 m and is native to Kashmir. Collected and marketed around Gilgit. The herb is used to season soups, clam chowder, fish and meat dishes (particularly poultry dressings). It is also used to season a number of other food items. About 1,500 tons of Thyme was imported into France, Germany, U.K. and the Netherlands in 1991. Price in 1994 was US$ 5,800.00 to 6,000.00 (Rs. 340.00 to Rs. 360.00 per Kg.).
PHC1:	Tonic, antispasmodic, emmenagogue, alexiteric, anthelmintic and carminative. Oil of Thyme is used in the treatment of whooping cough, convulsive cough, catarrh, sore throat, asthma and bronchitis. Good in liver complaints, pain in the spleen, liver or chest.
PHC2:	Leaves are laxative and stomachic. Oil is applied in toothache. Given for restoring weak vision, complaints of stomach and liver. Used for suppression of urine and menstruation. Used as a vermifuge (eliminates worms from the body), infusion also used in skin eruptions/ diseases.
C:	Sown in middle of March or early April in dry, mild weather. It is sown moderately thin, in shallow drills about 0.5 inch deep and 8 or 9 inches apart, in good, light soil in a warm position. cover evenly with soil. Grows easily in calcareous light, dry, stony soils. If grown on walls or in stony ground will survive the severest winters. Winter protection provided by banking up the soil. Manure well or use plenty of compost as the plant soon exhausts the soil.
P:	Stocks may be increased by dividing old roots or making cuttings, by slipping pieces of the plant with roots on them and planting out with trowel and dibber. Take care to water well. May be done as soon as the weather is warm enough from May to September. Old clumps may be divided as much as possible provided each piece has a reasonable bit of root.
OU:	Camphor of Thyme or Thymol is a powerful antiseptic for both internal and external use. It is also a preservative of meat.

5.54 GRAPES.

Vitis vinifera	Grapes (Angoor) are rich in bioflavinoids, vitamin C, phosphorus and potassium. Raisins are a good source of potassium, calcium, magnesium, iron and copper.
PHC1:	Atringents that help clear toxins from the body. Helpful for relieving rheumatism, liver and gallbladder complaints. Lower blood pressure.
PHC2:	May contribute to healing varicose veins. Sometimes recommended for poor liver function. Cleanses blood, liver and digestive system.
OU:	Sold as fresh and dried fruit.

5.55 CORN.



Zea mays	Corn (Makai) provides good supplies of carbohydrates, B vitamins (riboflavin and thiamine), vitamins A and C, potassium and zinc.
PHC1:	Tassel used to make tea to use as a soothing and healing diuretic, especially when kidneys have been injured by allopathic medicines or disease. Also helpful in gastritis.
PHC2:	Bed wetting in children, disorders of the prostrate, cystitis and inflammation of the urethra.
OU:	In industry to manufacture glucose and as flour. Plant also used as feed for cattle and small ruminants.

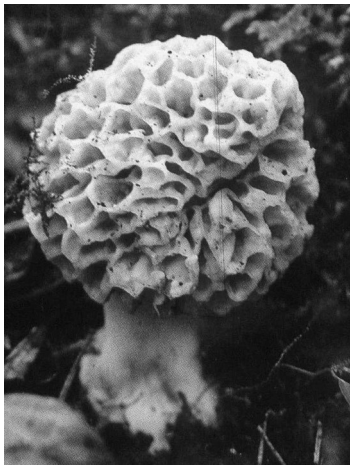
6. WILD MUSHROOMS:

Mushrooms are a food of high quality with high nutritional values. They are more valued in the West. Four species of Morels are found in the Galliyat area of Abbottabad District. Collected March to May, it is an important economic activity in the Galliyat area. Grows in moist shady places under small bushes and at the foot of big trees. Mushrooms of the local varieties are collected to be sold to middlemen who then export them to Europe. In France one Kg. dry weight of Guchi fetches US$ 400.00 or Rs. 24,000.00. Average fresh weight obtained by the locals is Rs. 3,250.00 per Kg. Fresh mushrooms contain 3 - 4 % proteins whereas dry mushrooms contain 30 - 50 % protein as it becomes chemically available. Over collection and destruction of natural habitat are contributing to increasingly rarity in obtaining these plants. There is a great need to study the plant and carry out research in propagation. These mushrooms can be cultivated quite profitably to fetch handsome returns in foreign exchange.

Tree Fungus (Serian).

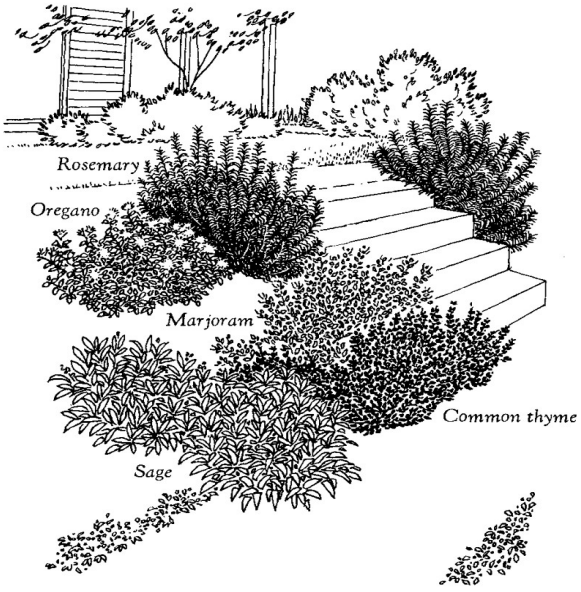
Morchella spp. Morels (Narela).

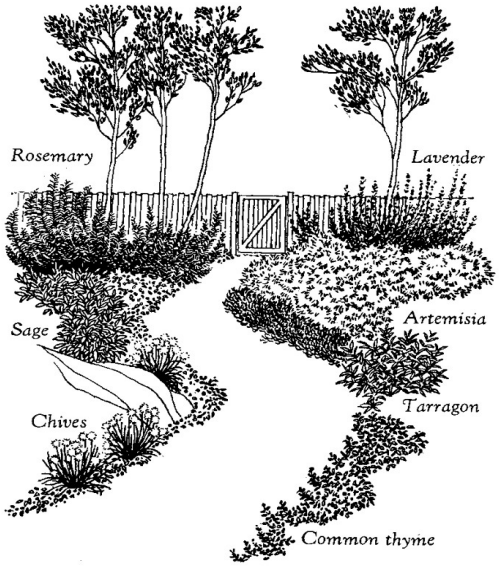
Morchella esculenta, Morels (Kali and Surkh Guchi).



7. CONCLUSION:

This paper is meant to bring out some of the possibilities and benefits that are inherent in herbs, spices and essential oils. There is a great need for scientific and applied research on the subject. A detailed and in-depth study is recommended. This is necessary to firstly remove any inaccuracies that have entered the above report. More essentially there are two major objectives. Firstly, the care and preservation of our natural heritage and biodiversity. It would be criminal to loose any of the valuable species of herbs that are provided to us by nature. Secondly, increasing populations and economic pressure needs to seek out avenues for positive and profitable economy generation and solutions to various health-related problems that beset human beings in this day and age. Environmental pollution and the ingestion of unhealthy water, food and air are causing a number of problems. Apart from protection of the environment, cures for many ills can be found in the plants that are growing around us.





CHAPTER 7: A WAY AHEAD:

1. Background:

The state of affairs in the Green Sector is positively not sustainable! At the present rate we will have completely exhausted our Renewable Natural Resources within a matter of a decade or two. The tremendous population pressure that we are exerting will soon reach crisis proportions. The era of beg and borrow is now almost at a close. It is a great shame that when there is plenty of scope for improvement and enhancement, we are forced to face a situation of need and scarcity. It is not my intention to expose our National Dirty Linen in Public. The tale is too well known to bear repeating. The causes of this situation are myriad and are beyond the scope of the present effort. However, the cures to some of the physical manifestations are presented for consideration. No claims to excellence are made; rather, an effort has been made to gather a bouquet of treatment. The present effort towards Devolution is a step in the right direction and should be supported. Vested interests may hide behind a screen of campaigning for Provincial Rights and declaring scarcity of capacity within Districts to be a limiting factor rendering them incapable of being masters of their own fates. An appeal is made to all right thinking individuals to cast aside the veils of prejudice and self-interest and take into account the sorry state of the environment and the fact that over 30 % of our population are faced with malnutrition! If this was a condition that was inescapable, it could be borne with resignation. When there is plenty of room for improvement and only a matter of getting our act together under visionary leadership, it is a crying shame.

2. The Stage:

Subsistence, non-irrigated agriculture is the rule rather than exception. Use of unstabalized fertilizers in inefficient manner is causing below grade water pollution and raising soil pH. Soils are depleted and yields are low. Poor cultural practices and lack of storm water drainage contribute to loss of precious topsoil in large quantities every year. Forests in the proximity are heavily exploited and not sustainable at 5 to 10 % of the area. Infrastructure in the shape of roads is less than sufficient and usually in a state of disrepair. Water supply is mostly self-arranged, due to sub-mountainous terrain this is usually a burdensome task. A few schemes in the area provide water to the doorsteps of about 30 % of the inhabitants. Springs and running streams are available. Recharging of shallow aquifers is slow and restricted. The area is increasingly facing water scarce months and lower rainfall in the two seasons that formerly prevailed, i.e. summer monsoons and winter rains/ snowfall. Electricity is practically available to all households. Telephones are rare but present. Sanitation is present though not hooked up to central or efficient systems. Solid and liquid waste is a major pollutant. Steep grades and poor maintenance standards of the few vehicles available to rural commuters are causing air pollution by emission of toxic fumes. Schools and Basic Health Units are lacking in facilities and under-staffed, both in qualitative and quantitative terms. Livestock is poor in quality and exerts pressure upon the existing resources. Local inhabitants resort to clearing of trees and burning of grass at particular seasons, to ensure more availability of grass to their ruminants. This grass is usually harvested in winter to supply winter-feed. Thus, overall, rural infrastructure is poor. However, rudimentary infrastructure does exist but is poorly maintained and grossly under-utilized. Over the years Governments and Politicians have contributed in well intentioned schemes that have failed to have maximum impact and have resulted in a great deal of waste and indebtedness. More emphasis has been placed upon infrastructure than economy generation. Opportunities and jobs have not been created. Resources have been over-exploited.

3. The Actors:

The people who fall into the categories of users, managers and regulators of the usage of Natural Resources may be classified, in say a Union Council, as follows:

3.1 The Local Communities that inhabit the area delimited as a Union Council, may be sub classified as:

a). Land-less households with members engaged in labor or service, either locally or outside the area.

b). Land owning small to medium households with members supplementing incomes by resorting to labor, service or small retail business, either locally or outside the area.

c). Perhaps a large land holding household or two with members supplementing incomes by resorting to service mostly outside the area.

These households consist of 6 to 8 members roughly evenly balanced between the two sexes, the three age groups vary as most in the young and roughly even in the middle and old age groups with a slight bias towards the middle age group. Education ranges from scarce in the older age groups and increases as age decreases. Quite a few households contain Middle to Intermediate qualified young men and women. Higher education is not absent from the area but consists mainly of non-technical degrees. A sense of deprivation and frustration prevails due to high cost of living and lack of access to facilities, employment, credit and opportunities. All this has led to erosion of social cohesiveness and a sense of rivalry and competition is prevalent. Intolerance and hostility are growing with increasing economic and social pressures. The poorest of the poor have been ignored and marginalized.

3.2 Particular Interest Groups: These consist of various social, political, economic and religious groups. Members of regular, formal or informal associations are finding an increasing share in influence. These consist of Community Based Organizations and emerging Cluster Groups; Service related associations or relationships and Sectarian groupings. Some are bound together as mutual interest groups linked through often, illegal ties. For instance an alliance between Contracts awarding authorities and contractors. Nepotism and illegal gratification prevails and strict accountability is now days being enforced through desperate necessity, caused by the sheer multiplicity and astronomical proportions in resource drainage.

3.3 Local Administration: This is as yet based outside the Union Council in the District Administration. However, the Devolution Plan calls for Citizens Boards and Village Development Councils operating within Union Councils consisting of elected Councilors from amongst males, females and minorities. The next tier will consist of Tehsil Councils and will lead on to District Councils. In case of single Tehsil Districts, like Abbottabad, this third tier will be absent. As present trends stand these Councils will most probably be dominated by the Particular Interest Groups. This is truer for the higher tiers. Citizen's Boards and Village Development Councils will hopefully be manned by members of Community Based Organizations. This is the immediate target group in so far as administration is concerned. The second group consists of the Union Councilors. Capacities are low and skills are absent. Interaction and cooperation is poor. Responsibility is not taken and balancing forces quickly curb and blunt initiatives. Meager resources are wasted and miss-spent, facilities are under-utilized. Non productive pursuits and a general free for all in exploitation is the order of the day. Inefficiencies and incompetence quickly serve to snatch away the fruits of any positive efforts. Technical knowledge, skills and facilities are noteworthy in their absence. The present District Administration is too heavily burdened, engaged in too many routine administrative tasks and

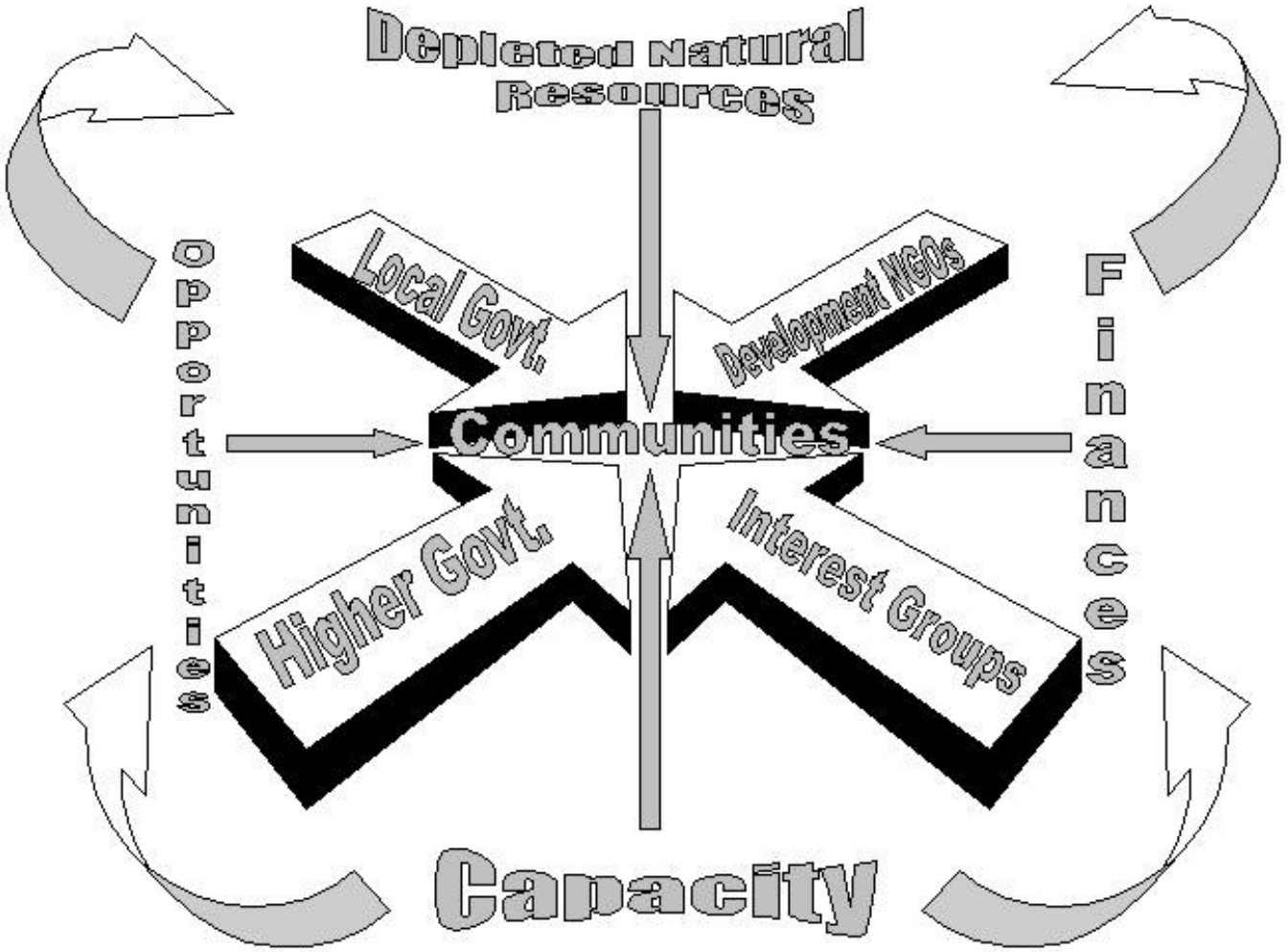
financially strapped to be able to conceive, what to think of implementing, dynamic and effective sustainable development.

3.4 Provincial & Federal Governments: The tier of Government that has had the most say in development and governance, through most of the existence of Pakistan, has been Provincial. Direct Central control has been exercised over them for many of these years. However, actual day-to-day implementation has fallen to the functionaries of the Provincial Governments and through them, to the Line Departments. At the Federal level a few National bodies like WAPDA, PTCL and NHA and some Regional bodies implementing Projects are playing their roles. Various Federal Ministries, Senators, as well as MPs of Provincial and National Assemblies and their associates have had their roles to play as well. Technical know-how and competence is greater and some notable attempts have been made to manfully cope with a situation in development, fraught with extraneous pressures.

3.5 Development Agencies/ NGOs: A growing number of Development Agencies and NGOs are very much evident in the Rural Areas. These are usually not locally based or even locally staffed. Social Mobilization, Women's Development, Micro Credit and Enterprise, Human Resource Development/ Capacity building, Small Projects Implementation and Natural Resource Management are some of their more significant activities.

Figure 1: Linkages & Requirements:

Figure 2: Relationships.



4. The Development Dilemma:

The Technological tools and knowledge that has become and is fast becoming available in the modern world, requires a great deal of expertise and experience to be used effectively. It is quite obvious that this level of skill is lacking. However, Information Technology is able to overcome this problem to some extent. A Sustainable Development Action Plan is a precise, detailed, highly technical and elaborate document. The present methodology that is being adopted for formulation of such a Plan, be it through the an International Organization or through the PE&DD of the Provincial Government or even what is proposed at Village, Union/ Tehsil/ District Council levels, can be improved. The need is pressing and the intent quite correct, however the methodology needs to be altered. Even the blanket implementation of the Devolution Plan will face many problems, unless it is implemented incrementally and supported with complementary activities as outlined. The existing effort by the District Conservation Strategy Support Units of the IUCN based upon a process of National Conservation Strategy – Sarhad Provincial Conservation Strategy (Baluchistan Conservation Strategy) and District Conservation Strategy have been designed in the pre-devolution phase of Government. Decentralization being a key recommendation of all earlier Strategies there is all the more reason for coming up with a complete and implementable strategy at District level. At present some of the thinking is based upon earlier experiences in the Sarhad and Chitral District Strategies. Some of their concepts are outlined below:

4.1 Challenges.

- Operationalisation of District funds to address local issues at the local level.
- Bridging the gap between Civil Society and the Public Sector and improving access to Social Sector facilities.
- Integration of Conservation and Sustainability aspects of development in the current process of Nation building.
- Limited autonomy of Line Departments at District level – need for devolution.
- Delegation of legal backing and power to local forums.
- Equitable and participatory investment of Public funds on local needs.

4.2 Rationale:

- Lack of participatory, needs based and integrated development at the District level.
- Lack of interface between the Public and Private Sectors.
- Lack of District input into Provincial development plans leading to ad hoc and lower impact development interventions.
- Lack of equitable development due to non-involvement of locals and centralized development planning and execution.
- Lack of Institutionalization of effective mechanisms to foster decentralization of the development process.
- Local capacity building in environment and development.

4.3 Mechanisms of Strategy Formulation:

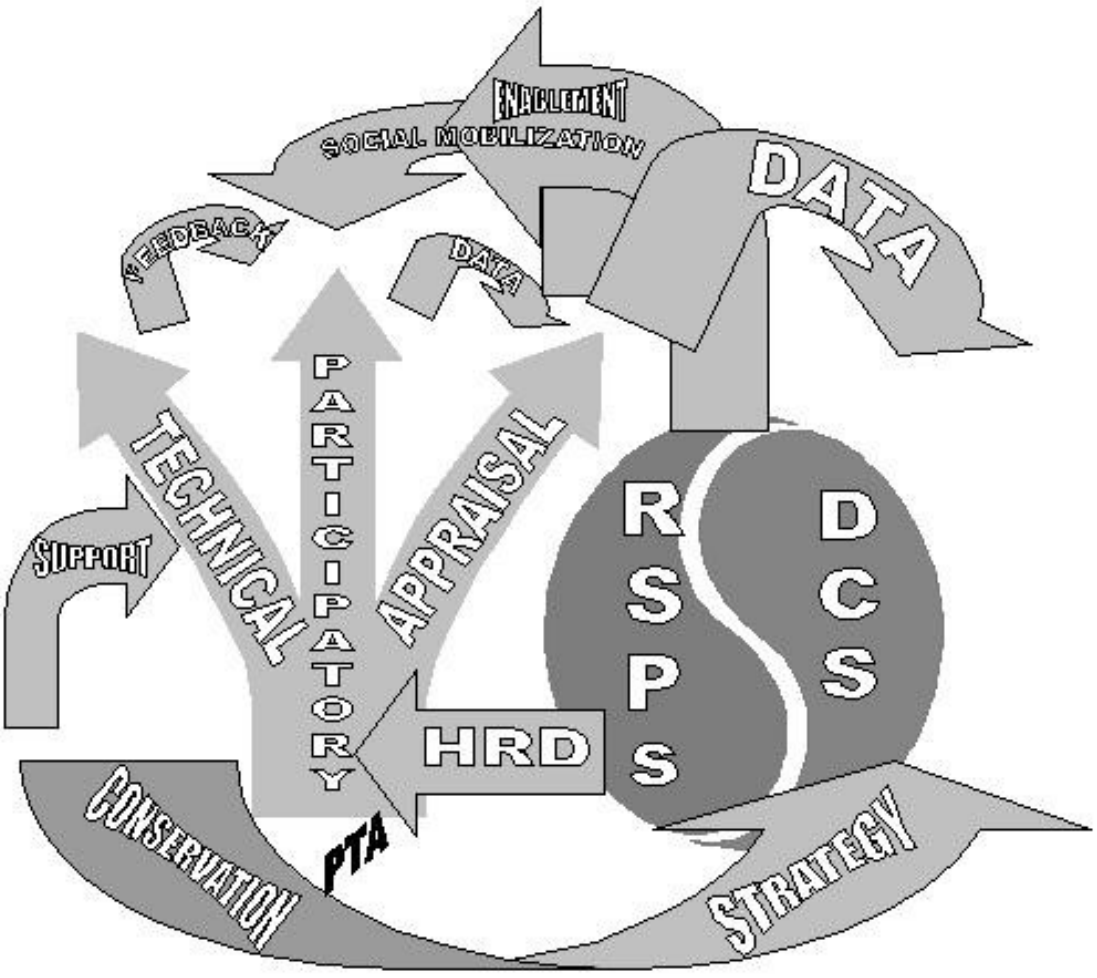
- Preparation of Introductory paper/ inception report and its distribution amongst Stakeholders.
- Formation of Round Table of District Stakeholders consisting of Government members and Civil Society.
- Formulation of Steering/ Executive Committee.

- Public Consultation process, Union Council, village level. Male and Female groups.
- Identification of priority issues/ sectors.
- Commissioning of Sector papers.
- Preparation of Strategy Document.
- Commissioning of Case Studies to elaborate on prioritized issues.
- Continuous liaison and coordination with partners.

4.4 It is suggested that this process would benefit greatly from input of up to date primary data. Some of the measures and framework that could accommodate them are outlined in this paper. If "Strategies for sustainability are processes of planning and action to improve and maintain the well being of people and ecosystems" then these measures would greatly aid the process and bring some order in the picture. It is necessary to know the current state of the well being or otherwise of the people and ecosystems before planning and action to improve and maintain them can be possible. This presupposes the requisite knowledge of how and why ecosystems function and the dynamics of socio-economic conditions within which they interact with people.

4.5 What is required is firstly to establish a Detailed Sustainable Development Action Plan. This can be done by adopting a three pronged approach supplemented by a triple intervention effort.

Figure 3: Three Pronged, Three Dimensional Approach, PTA:

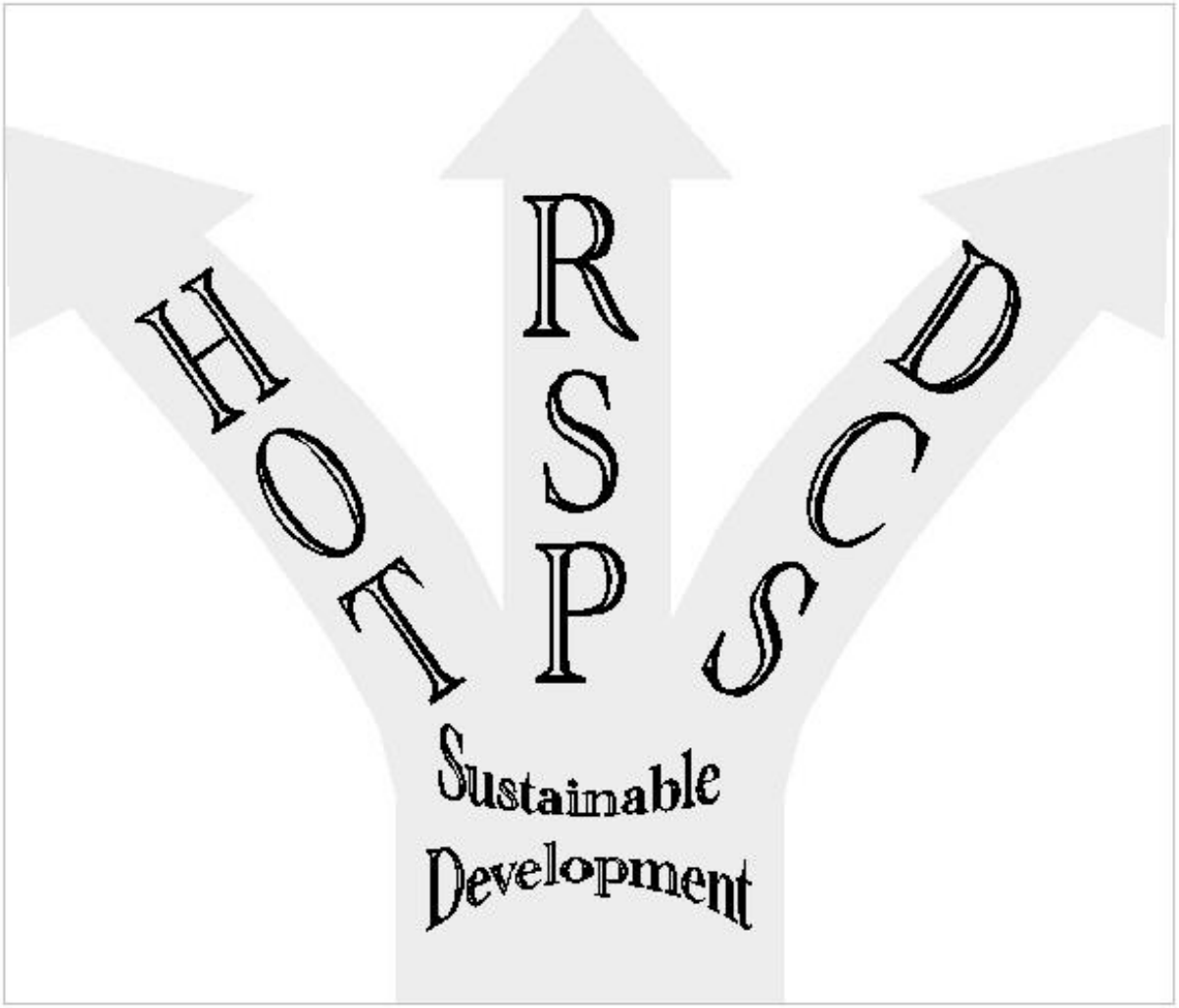


5. Framework:

Thus, three separate but coordinated bodies need to work harmoniously together, in order to achieve a practical and implementable Sustainable Development Action Plan. This is only possible if a single controlling authority is provided the mandate to carry out the task. The three bodies are:

5.1 Conservation Strategy (Technically qualified and experienced).
5.2 Rural Support Organization (Highly experienced and locally staffed). Specializing in Social Mobilization (Community Based Organizations, male and female), networking (Cluster Groups) and Micro Finance for micro Enterprise.
5.3 Human Resource Development {highly skilled and well equipped specializing in Hands on Training (HOT)}.

Figure 4: The Three Prongs.



6. Implementation:

The above outlined program should be tried out on ground in a single District or association of two Districts. The Sarhad Rural Support Corporation is working in regions of two Districts. A nexus between three bodies, as mentioned in para. Can be established and a trial program can be implemented in a District or two. Devolution authorities need to sponsor the activities envisaged and be involved through the aegis of the District Development Authority. Skills in networking will be able to carry out the task with as little friction as possible. With practical implementation on pilot scale, monitoring and evaluation will be able to fine tune the effort and present a replicable project within a time span of 2 years. This would include the establishment of a dynamic HRD unit; capable of churning out requisite hard and soft training material that could be adapted to other areas with minimum added input. Secondly, templates, standardized forms and standard operating procedures (SOPs) would be worked out and established for duplication in the rest of the Country. The implementation of Projects is the real stumbling block for progress. The proposed District Administration needs to be well organized and in possession of clear cut and transparent development plans. Even the best and meticulously laid out of plans will fail to achieve the desired results with poor implementation. Apart from HRD there is a need to deploy Management Tools to achieve the desired results. Some such tools for use by the District Strategy Team are:

- Field Survey.
    - Aerial Photography.
    - Satellite Imagery.
    - Ground Survey.
    - Field Sketch/ Plan.
- Management Survey.
    - Job Analysis.
    - Job Evaluation.
    - Management Audit.
    - Reorganization/ re-equipment.
    - Monitoring & Evaluation.

7. **Field Survey**:

7.1 The use to which it will be put is what determines the scope and extent of a Field Survey and consequently fixes a limit to its extent. We have the territory of a District for which a Sustainable Development Action Plan is required. It would serve our purpose admirably to prepare a Surface Condition Land Plan of a scale of 1 cm: 20 m. Separate sheets capable of being superimposed upon each other would carry details of different categories. These categories could be:

- Administrative and Financial:
    - Demographic.
    - Revenue estates/ land tenure.
    - Villages and Mohallas.
    - Land values.
    - Zoning.
    - Historical, cultural and scientific.
- Public Services:
    - Water Supply.
    - Sewerage.
    - Drainage.
    - Electricity
    - Telephone.
    - Gas.
    - Roads/ tracks.
- Physical:
    - Agriculture.
    - Vegetation.
    - Wildlife.
    - Built-up Areas.
    - Topographical.
    - Hydrological.
    - Soil Conservation.
    - Geological.
    - Seismic.
    - Land use.
    - Land Capabilities.
    - Planning/ projections.

7.2 The afore mentioned maps would necessitate the gathering of Bench Mark data of technical nature. It would establish the present conditions in graphical details. From this basis and foundation it is possible to make a Sustainable Development Action Plan. This plan would be an effort to shape/ guide and channelize physical growth and usage in accordance with the principles of **ESP**:

- Economically feasible (**E**conomic).
- Socially Just (**S**ociological).
- Environmentally Sound (**P**hysical).

This would include improvement or re-planning of existing usage as well as determine a framework for future usage. Thus the plans should cover projections of as many years into the future as deemed necessary (10 years, 50 years, etc.). Due to lack of planning and control we are saddled with Ribbon Development that takes place along main roads and highways. Each individual seeks to extract maximum benefit from road frontage and builds as suits them the most without consideration to the requirements of others or overall community requirements. Legislation to prevent such development must be made and implemented at all costs in order to avoid chaos and related civic problems.

7.3 Zoning is termed as the method of regulating Land use in accordance to the best use that suits the overall community and the area itself by restricting usage and arranging components of the area in relation to a specified plan. The overall distinction is made between the following categories:

- Urban.
    - Civic.
    - Business.
    - Industrial.
    - Residential.
    - Recreational.
    - Institutional.
    - Cultural Heritage.
- Rural.
    - Built-up area.
        - Residential.
        - Commercial.
        - Institutional.
    - Agricultural.
    - Rangeland
- Wilderness.
    - Forest.
    - Recreational.
    - Pristine.
    - Reserves.
    - Parks.
    - Protected Areas.
    - Heritage.

Zoning is important for Sustainability as well as the equitable public regulation of private and government property. A zoning exercise is rigid only in so far as topological details are concerned. Principles should be adhered to without going into too many details. This leaves room for rational adjustments in accordance to future requirements. Use density in any sense is specified and sustainability or using without using up or causing irretrievable damage is ensured.

7.4 Procedure: The procedure and manner of carrying out the exercise can be as follows (with necessary alterations depending upon specific sites).

- Declaration of Intent.
- Submission of Plan and Budgetary estimates (1 month).
- Government Sanction.
- Invitation of Public objections (1 month).
- Government consideration of objections, holding of inquiries if required and subsequent sanction for preparation (1-2 months).
- Preparation and publication in consultation with stakeholders (12 – 18 months).
- Invitation of Public objections to draft scheme (1 month).
- Consideration of objections, modification of draft scheme if required and submission for Government sanction (4 months).
- Sanction of draft scheme and appointment of arbitrator.
- Arbitrator proceedings for each area, publication of award and submission of detailed proposal (6 - 12 months).
- Scrutiny of proposals by Tribunal of Arbitration, public proceedings and decisions (4 months).
- Final scheme forwarded to Government.
- Final sanction after scrutiny and financial implications determination (5 months).
- Enforcement (1 month after sanction). 36 to 48 months.

7.5 Objectives: The objectives of the exercise are:

- Provides overall framework for Sustainable development.
- Enables orderly expenditure of Public funds in prioritized manner on projects of permanent, constructive and sustainable value.
- Stimulates wider interest in and understanding of development and environmental issues.
- Minimizes mutual conflict and brings about harmony and understanding between different groups and members of society.
- Ensures stimulation of and ensures basic economy generation.
- Protection, preservation and enhancement of the economic, social, cultural, environmental and aesthetic character of the District.

7.6 Bill:[1] The urban sprawl and haphazard, unplanned construction in the District especially in the thickly populated areas has created problems not only directly related to growth but has begun to endanger the environment and our very way of life. It has therefore become necessary to empower and give guidelines to the local bodies to immediately arrest such growth. Hence the Bill to enable local councils in the Abbottabad District to specify areas for Land Use.

Whereas it is expedient to enable local councils in the Province to specify and designate areas in their local limits for land use for the management of growth, encouraging comprehensive planning, governing the development and use of land, regulating non-conforming use and to preserve the environment and our way of life and matters ancillary thereto in a manner that is economically feasible, socially just and environmentally sound in order to achieve Sustainable Development.

It is hereby enacted as follows:

1. This act may be called the Abbottabad District Local Council Land Use & Sustainable Development Enabling Act, 2001.

* *A simple enabling provision could of course be inserted in an already existing Act, however, this Act envisages the outline of the sort of zoning required by a Local Council.*

1.1 It shall extend to the whole of the District.

1.2 It shall come into force at once.

* *Although certain Nature Reserves have been declared by the Federal Government, there is no law either Provincial or Federal that would enable any Department or Organization to do so.*

2. In this Act unless the subject context otherwise requires:

"Construction" means any man made structure whether temporary or permanent, built upon the land requiring displacement of earth or change in nature of the land.

"Designated" means designated by a Notification issued by the Local Council.

"Government" means Government of Abbottabad district.

"Local Areas" means an area under the jurisdiction of the Local Council.

"Local Council" means a Local Council constituted under the N.W.F.P. Local Council Ordinance, 1979 but does not include the Union Council.

* *Union Councils have been excluded from Local Councils, as it would create insurmountable problems at that tier of Government.*

"Record of Rights" means and includes the document detailed in section 39 of the N.W.F.P. Land Revenue Act, 1967.

"Shamilat" means and includes any area so shown in record of rights.

"Zone" means an area specified or designated under this Act.

* *The District should be enabled to plan and specify areas for particular use in order to realize its own needs and secondly to involve the community itself in the exercise. The list of*

[1] Anjum Saeed, Rotary Club Abbottabad.

zones has been shaped not to be overly specific but only to provide a framework towards planning. It shall ensure that haphazard overlapping of each zone does not take place. At the same time it would make it incumbent upon each Local Council to carry out zoning exercises as the following section puts a moratorium upon all construction until this exercise is completed. This list is not exhaustive and may need further vetting of town planning etc.

3. The Local Council shall designate the Local Areas within the Local Limits into one or more of the following Zones:

Zone A.
Low density residential areas consisting of single or double story residential detached homes of not less than 1 kanal plot size along with allied facilities and laid down setbacks.
Zone B.
Medium density residential areas consisting of double story houses of less than 1 Kanal plot size with allied facilities and laid down setbacks.
Zone C.
High density residential areas of no limit on plot sizes and erected structures and allied facilities there upon.
Zone D.
Commercial area consisting of retail shops, bazars and markets.
Zone E.
Commercial areas consisting of no limits, high rise shopping malls and other retail outlets and commercial bazars.
Zone F.
Commercial area consisting of service areas such as motor mechanics and other service providers requiring large plot sizes.
Zone G.
Warehouses, godowns and mundies.
Zone H.
Industrial areas consisting of small and medium size industries and cottage industries.
Zone I.
Industrial areas of no limits large industries.

* *The proviso will ensure that the courts could go into the question of malafide changes thereby keeping a check upon such misuse.*

Zone J.
Agricultural area where no construction of more than 2000 sq. ft. is allowed for a minimum plot of 3 acres or more.

* *Urban area planning is already envisaged in the local body's ordinance, however, this has not been implemented. This section will not only solve that problem but shall also include the unplanned urbanization taking place in the rural areas.*

Zone K.
Forest areas with regulated felling/ re-planting.

Zone L.
Rangelands for grazing/ pastures.
Zone M.
Natural reserves where no construction, agriculture, hunting or any human activity is allowed.
Zone N.
Shamilat land, community service areas such as parks, schools, mosques, grazing land, graveyards, etc.
* *The concept of Shamilat exists traditionally in our society. This concept is incorporated in the record of rights; the absence of any law regulating the use of such land has defeated its envisaged purpose of common village land to be used by its owners for collective benefit. This section aims to remedy that problem and give to the local council large tracts of land which could be used by them for community development and at the same time ensure and arrest misappropriation by individual deh owners and preserve village communities as we know them today. It would also ensure resumption of all such land that has been encroached upon over the years.*
Zone O.
Any other zone with the prior permission of the Government.
* *As the above section takes away the rights of the individual to make any construction after the designation of the zones and it is envisaged that all areas of the District (except the cantonments) shall be so zoned, it would be necessary to safeguard the existing construction. However, it is also envisaged that at a point later in time these areas must also fall in line with the designated zones as we have already allowed cancerous growth to overtake our cities and villages.*
4. The local council may redesignate any zone or change its boundaries with the prior permission of the Government, provided that such a change or redesignation is not made maliciously.
5. A complete moratorium is hereby placed upon all construction and land use in the District until:
5.1 Master plan has been drawn under section 76 of the N.W.F.P. Local Government Ordinance, 1979 and approved by the District Government.
5.2 The local council for the areas falling within their local limits specifies zones.
6. Ownership and possession of Shamilat lands shall be deemed to vest exclusively in the local council within whose local area the shamilat is situated.
7. The existing construction legally made before the commencement of this Act shall remain outside the ambit of this law until a procedure is laid down by the local council in the rules framed under this Act whereby a time frame shall be set out to put the existing construction in conformity with the zones specified under this Act.
8. The local council may:
8.1 Make rules to carry out the purpose of this Act.
8.2 Make bylaws to further manage, control and govern the zones designated by the local council.
9. Legal implications:
9.1 Who ever contravenes the purpose of this Act or the rules or bylaws made under this Act shall be punished with fines extending up to Rs. Five Hundred Thousand.
9.2 The Court trying an offense under this Act shall order the demolition of any construction in contravention of the specified zone.

8. Aerial Photography:

8.1 Introduction: The technique of applied photo interpretation is a tool, which increases a conservationist's capability to plan and accomplish his work. By examining photographic images and patterns it is possible to identify objects or conditions and evaluate their significance.

8.2 General: Aerial photographs of an area can be used for many applications, scientific studies such as:

- Geology.
- Forestry.
- Soil Conservation.
- Geography.
- Archaeology.
- Engineering.
- Zoning.
- Planting.

8.3 Terrain and vegetative cover comes into sharp relief in the form of stereograms, which can be studied, in minute detail. Aerial photographs can be viewed in three dimensions by using overlapping pairs of photographs, or as map substitutes in the form of mosaics. By viewing photographs in the third dimension (depth), the topography is immediately apparent. The heights of buildings and trees can be recognized, stream and drainage channels are obvious and an entirely new appreciation of the image detail is realized.

8.4 Practical Application: The following is a tabulation of opportunities as they are recognized by the U.S. Forest Service:

8.4.1 General:

- To determine areas, locations, type and distributions of ground cover.
- In the office or in the field, as a means of orienting yourself to new or unfamiliar areas – such items as:
  - Topography.
  - Cover Types.
  - Soils.
  - Rock outcrops. or formations.
  - Roads and trails (travel routes).
  - Distance and bearing between points.
  - Location of water.
- As a map in the field or in the office.
- As a basis to determine accessibility and the best means to travel.
- As a means to determining feasibility for using various types of equipment.
- In planning search and rescue missions to determine the most likely search areas and means of access.

8.4.2 Fire:

- Location.
- On fire control planning:
  - Fuel types.
  - Access.
  - Line location.

        - Behavior prediction.
        - Hazard area identification.
        - Determining feasibility of equipment use.
        - Camp locations.
        - Helispots.
        - Water points.
    - Pre-suppression Planning:
        - Fuel types.
        - Soil types.
        - Rate of spread.
        - Resistance to control.
        - Value classes.
        - Equipment chances.
        - Water chances.
    - Basis of seen area maps from look out towers.
    - Dispatchers – accessibility, topography, cover and fuel types.
    - Damage appraisals.

8.4.3 Timber:

- Locations, species, age classes, condition classes, stand height, volume, logging conditions.
- Logical layout of logging plan (units), road systems.
- Timber stand improvement areas, slash disposal, erosion control.
- Management planning.
    - Working Circle and compartment boundary layout.
    - Site classes.
    - Timber types, age classes, condition classes.
    - Worksheets (composites) for compartment examination.
- Insects and disease surveys.

8.4.4 Range:

- Location of Range improvement sites (tanks, corrals, fences, and pasture).
- Location of existing improvements.
- Calculation of drainage areas and storage capacity of dams.
- Logical locations for pipe lines.
- Allotment analysis:
    - Suitability classes.
    - Problem areas (insects, animals, erosion, over grazing, noxious plants (invasions).
    - Barriers to livestock movement.
    - Relationships to water points.
    - Land ownership patterns.
- Planning for construction of improvements, access (means of travel needed), source of materials (stays, posts, water, sand, etc.).
- Noxious plant control planning.
- Layout of re-vegetation projects.

8.4.5 Recreation:

- Preliminary location of recreation sites (picnic areas, campgrounds, summer homes, ski runs, docks, ramps, etc.).
- Access road and trail planning.
- Facilities siting.
- Medical/ emergency covers.
- Security measures.

8.4.6 Wildlife:

- Cover areas.
- Ecotone (edge effect areas), openings.
- Herd unit locations.
- Summer, intermediate, winter range.
- Water.
- Game trail locations.
- Food (browse, mast, seed) areas.
- Soil types.
- Game counts (special photographs).

8.4.7 Watersheds:

- Laying out watersheds and drainage patterns.
- Size and cover types of watersheds.
- Prediction of moisture conditions – snow pack runoff.
- Slope gradients.
- Water rights filing.

8.4.8 Soil:

- Soil types.
- Parent materials.
- Moisture conditions.
- Erosion control planning.
- Geologic action.
- History of soil developments.
- Erosion sites.

8.4.9 Exchange:

- Preliminary examination of lands; comparability, access, cover, resource values, improvements.
- Planning.
- Desirable lands for acquisition and exchange.

8.5 Conclusion: only imagination and ability, familiarity and willingness to use limit Uses. Aerial photographs used in conjunction with physical recce, good maps and satellite imagery are an unbeatable combination. It is strongly urged that immediate steps be taken to adopt these practices in order to achieve sustainable development (socially just, ecologically sound and economically viable) of our resources.

9 Land Record Reform:

9.1 Introduction: A close scrutiny of our entire Land Record and Revenue System will reveal a Pandora's Box of wrong and injustice. This major problem has to be faced and corrected on a priority basis! It is no service to our Society to behave like the proverbial ostrich and hide our heads in the sand. Is this problem so basic? You might well ask. I propose to prove it to be a major source of evil and a stumbling block on the path to progress.

9.2 Hurdle: The prevalent Patwar System is the very basis that prevents progress and leads to corruption for the following reasons:

9.2.1 Litigation: Prevalence of long running litigation between various claimants of land leading to:

a) Blood Feuds.
b) Waste of valuable time and money in pursuing cases.
c) Over loading of the Judicial System.
d) Justice delayed and denied due to corruption.
e) Cause of deprivation, frustration and disillusionment.
f) Mine of corruption.

9.3 Fraud: Misappropriation of Public and Private Lands due to active connivance and participation of Land Record Staff, taking advantage of confusion in records.

9.4 Revenue Loss: Siphoning off of Government Revenue leading to colossal losses.

9.5 Economic Loss: Inequitable distribution of land and uneconomical holdings, leading to non-utilization of land to its true potential.

9.6 Black Money: Use of land as a cover for black money and ill-gotten gains, as records are not easily checked.

9.7 Poor Planning: Impossible to effectively plan and use land for maximum advantage in both rural and urban areas leading to:

9.7.1 Congestion.
9.7.2 Pollution.
9.7.3 Waste.
9.7.4 Lowering of Quality of Life.
9.7.5 Progressive degeneration, due to bad, or absent long-term planning.
9.7.6 Improper planting and raising of crops leading to deficiencies and resulting in expensive imports.
9.7.7 Setting of bad example to coming generations.

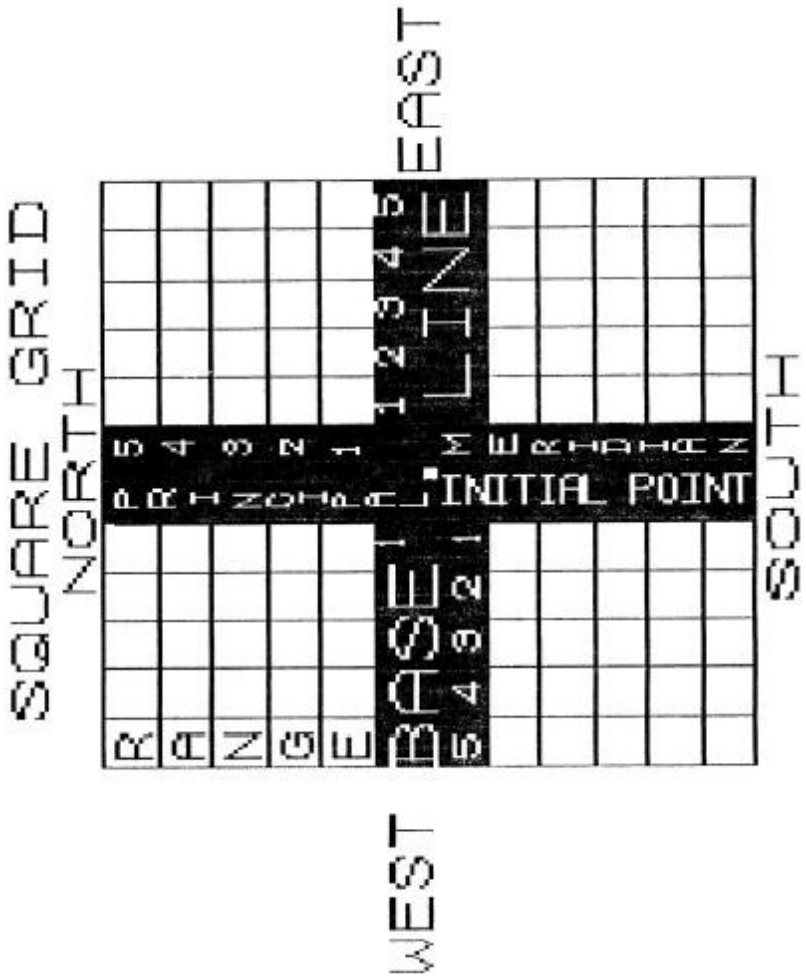
9.8 Requirement: From the foregoing, it should be more than obvious that this problem is both serious as well as of fundamental importance to all future planning and implementation. Thus efforts are required to correct the system immediately. The following measures are advocated:

9.8.1 Complete Satellite Survey.
9.8.2 3-D Color Negative Aerial Photography.
9.8.3 Survey for, and preparation of, 20 cm to I Km scale plan maps**.**
9.8.4 Computerization of Records and Maps.

9.9 The map: The basic of map making is the Grid System. The Modern Universal Metric System should be adopted right down to Marlas and even below. Quite obviously a 1-cm: 20m

map would actually represent a plan. Every field can be denoted to square meters. Detailed scale down to true width of roads and streams can be accurately depicted. The first step is to establish an initial Point, the longitude and latitude of which is known. Then, a True North and South line called a "Principal Meridian" is run through the Initial Point and marked on the ground. Next a line is run East and West from the Initial Point. This is called a "Base Line" and is perpendicular to the Principal Meridian. On either side of the Principal Meridian land is laid out in approximately square units of 5-Km square. Each "Square" is divided into 25 "Sections" approximately I Km square. Each Section can be further sub divided right down to square meters if so required. Each Square thus contains Sections numbered I to 25 starting in the North East corner and moving alternately left to right then right to left, ending in the South East Section. A Tier of Squares is called a "Range". Thus its Number, Square and Range can locate each Section. The Squares being described as so and so Squares, North or South of a named Base Line and so and so Squares, East or West of a named Principal Meridian. Sections may be further sub divided into "Quarters" and identified by its compass direction - NE; SE; SW; NW. The corners of each Section and Quarter Section can be permanently located on ground by building small monuments. The exact location of the corner is stamped into a brass cap on top of the monument.

Figure 5: The Grid System:



NW 1/4 NW 1/4	NE 1/4 NW 1/4	NORTH EAST QUARTER	NE 1/4	E 1/2 SE 1/4	
				WEST HALF SOUTH EAST QUARTER	
SW 1/4 NW 1/4	SE 1/4 NW 1/4			N 1/2 SW 1/4	

5	4	3	2	1
9	7	8	9	10
15	14	13	12	11
16	17	18	19	20
25	24	23	22	21

Figure 6: Locating on the Grid System:

9.10 Justification: Quite evidently this massive exercise would be-quite expensive to undertake and Staff. In order to justify the expense, I would point out that after Computerization of Land Records and adjustments as in "Jumah Bandi", obviously disputes will arise and should be immediately and impartially settled on a priority basis. Secondly, existing Staff will no longer be relevant as Computer Operators would have to be inducted and trained. With roaster records and duplication, fraud will be eliminated and much land recovered from the corrupt. Sale of these lands and recovery of Government Lands will yield massive returns. It is reasonably safe to assume that lands now held by the very Staff engaged to keep records will alone suffice to more than pay for the exercise. These funds generated can be used to reimburse the expenses incurred. Thirdly let us look at the disciplines that would use the information gained and present further spin offs;

9.10.1 Planning & Development.
9.10.2 Soil Conservation.
9.10.3 Agriculture.
9.10.4 Forestry.
9.10.5 Fishery.
9.10.6 Wildlife Management.
9.10.7 Geology.
9.10.8 Mining.
9.10.9 Natural Resources utilization.
9.10.10 Geography.
9.10.11 Civil Engineering.
9.10.12 Civil Defense.
9.10.13 Military Defense.
9.10.14 Flood Control/ Natural Calamities Management.
9.10.15 Industry.
9.10.16 Land Record/ Revenue.
9.10.17 Population Welfare.
9.10.18 Election Authority.
9.10.19 Irrigation.
9.10.20 Environment Protection.
9.10.21 Financial Institutions.
9.10.22 Trade and Commerce.
9.10.23 Meteorological Departments.

9.11 To be more specific let us enlist some of the practical uses:

9.11.1 Study of Wind Action/ Erosion.
9.11.2 Ground Water Surveys.
9.11.3 Mass movements.
9.11.4 Glaciers Study.
9.11.5 Watershed Management.
9.11.6 Desert Control.
9.11.7 Water Erosion and erosion cycles.
9.11.8 Lithology (discrimination of rock types).

9.11.8 Rock Structures.
9.11.9 Vegetation.
9.11.10 Soils.
9.11.11 Rural/ Urban Planning.
9.11.12 Communications (Roads, rail, water, phone etc.).
9.11.13 Forest measurement, plantation, and fire control.
9.11.14 Land Use & Land Capability Maps.
9.11.15 Crops planting, pest controls.
9.11.16 Land Revenue assessment.
9.11.17 Land sale/ purchase.
9.11.18 Long Term Planning.
9.11.19 Civil/ Military defense planning.
9.11.20 Mineral/ 0il/ Gas exploitation.
9.11.21 Irrigation.
9.11.22 Drainage.
9.11.23 Electricity provision.
9.11.24 Election exercise.
9.11.25 Census Operations.
9.11.26 Export of harvests and yield.
9.11.27 Mortgage of lands for projects.
9.11.28 Weather forecasting and effects.

9.12 Method: The cadre recruited, as mentioned in the introduction, would be utilized both for initial survey and subsequently for manning the new posts created. Due to the fact that the National Census has been carried out, this exercise can be carried out as a Post Census exercise. Secondly it appears that many Foreign Agencies have funded and even carried out exercises that should be collected and used for these purposes. For example surveys carried out by Oil Exploration and Drilling Companies and Detailed Soil Surveys of the Geological Survey of Pakistan, presently classified as restricted. These, and other data, lying unused in various Government Departments, should all be collected in one place and proper use be made of them. Additionally, these reports and the fruits of the labor of the subject under discussion should be available to the Public so that economic possibilities may be examined and pursued. This exercise can be carried out under the Administrative Support of the Pakistan Army.

9.13. Existing Structure: The present system, run from the Deputy Commissioners office, consists of a chain headed by the Tehsildar, followed by a Naib Tehsildar; Gardawar/ Qanungo and finally the Patwari. Records are kept on Cotton sheets and the system dates back to the times of Todar Mal in the reign of the Emperor Akbar. Usually the Patwari is employed on "Sifarish" from the powers that be in the districts. The characteristics of these functionaries are proverbial and there is no necessity to recount them. However it is a fact that they have enriched themselves considerably at the expense of the Exchequer and the general Public. This exploitive and corrupt system has to be eliminated immediately, if there is any hope for progress. There is no question of window dressing. The exercise has to be complete. The powers of the new structure have to be curtailed to exclude the all-encompassing purview of the present incumbents. These powers have taken up the posture of rulers and petty despots. The

duties of the Patwari are as follows:

9.13.1 Maintains Record of Land Ownership.
9.13.2 Effects Transfer and mutation of Land.
9.13.3 Maintains Record of Mortgage and alienation of Land.
9.13.4 Estimates value of crops for Revenue purposes.
9.13.5 Assesses damage from Natural calamities.
9.13.6 Channel for Relief measures.
9.13.7 Channel for Government Subsidized Crop purchases.
9.13.8 Maintains Record of Government Land and Lease.
9.13.9 Aids Election/ Census/ Flood Relief Authorities.
9.13.10 Channel for collection of "Abiana" and "Ushr".

9.14 Suggested Structure: It is suggested that there should be a division of work wherein Maintenance of Record be retained with the DCs office and assessment and collection be transferred to elected representatives at Village and Mohallah level. The reason for this is that once any transaction or change is effected in the status of land, it should be given a computer number and date. This date should be automatically entered in records and Updating and Compliance Report is completed within a stipulated time frame. In case there is any delay there should be an inquiry and those responsible be taken to task. This function should be totally clerical and no power of delay or blackmail is afforded to the personnel responsible. Weekly reviews of the Record are made and Monthly Reports be submitted to higher Authorities. Periodical checks and Management Audits be carried out to ensure that work is being done in accordance to the laid down rules and procedures. In so far as assessment and collection is concerned, it will be greatly facilitated by the separate records and a permanent check will be maintained. Elected representatives will perforce comply with rules of justice and equity in the fear of losing votes. They will be unable to extend undue favor by the check of established targets held in the records. In the case of unholy alliances between the Records and Collection Agencies, the Management Audit will play its due role. Political Opposition and Social Welfare Organizations should be adjusted in this role. Computer search programs can detect misappropriation practices.

10. Conservation Planning: The basic wealth of any Country is its Natural Resources. These are divided into renewable and non-renewable. A just and equitable use of these resources is a rational use that provides benefits to all and ensures that this use is sustainable. This means using without using up. Ensuring that Natures abundance is not abused and only used in such a manner that it continues to provide its living abundance to all coming generations. We are presently concerned with two of the three major renewable resources. These are the soil and water. Our present and past usage of these resources leaves much to be desired. The Ecological Systems that sustain us are inter-linked and fragile. Thoughtless over exploitation renders them subject to degradation and eventual failure. Some of the immediate threats we are facing, in Abbottabad District, due to our negligence are:

- Soil erosion.
- Decline in soil fertility.
- Increased soil borne pests.
- Denuded Watersheds.
- Ravaging flash floods.
- Increasing aridity.
- Receding Water Tables.
- Climate change.

This results in reduced agricultural capacity, while population pressures continue to mount. To overcome these grave problems it is all the more necessary to make detailed and realistic plans for proper soil and water use and their consequent rejuvenation. Subsequently it is imperative that these plans be carried out in letter and spirit. The first conclusion that is drawn from any preliminary survey of the Districts Land and Water usage is that it is inappropriate to say the least. Primary data, that has been collected, supports this statement. In order to come up with a realistic Conservation or Sustainable Development Action Plan the first step is to make a Land and Water Resources Inventory. This is subdivided into Land and Water.

LAND INVENTORY: It is important to keep in mind the reason of making a Land Inventory. This is to provide the requisite Primary data that will enable maximum and rational use of every acre of land within the District. Maximum in terms of economic returns that keeps in mind limited resources. Rational in terms of harmony with Nature and sustainability for coming generations. A Land Inventory is the first step towards ascertaining Land capability.

11. Job Analysis & Evaluation:

11.1 Introduction: We should be more then clear in our minds as to the vital importance of this exercise. Indeed it is the very foundation upon which the edifice of effective Government is built. As we all know a great deal needs to be done to reconstitute and invigorate the Departments that deal with our very existence.

11.2 General: Constant shifting of priorities and changing work conditions have a poor effect upon the workers involved. It is important to lay a strong foundation and build up a permanent tower of excellence. We have at our disposal a great deal of expertise; numerous instruments; will and dedication. What is required is to fuse them together into an orderly whole. This requires vision and determination. Only selfless efforts of great magnitude will be able to sift through a riot of confusion and negative attitudes to reach the core of the problem and subsequently solve it in the best and most efficient manner.

11.3 Organization: The orderly deployment, to make best possible use of all resources, is termed as Organization. Strong and viable organization is the only means of achieving satisfactory results in any field. It is with organization and motivation that seemingly insurmountable problems can be overcome.

11.3.1 The symptoms of bad organization are:

- Unacceptable delays.
- Difficulty in locating documents.
- Difficulty in retrieving information.
- Lack of authority necessary to perform the duties of a particular job.
- Lack of Coordination.
- Duplication of procedure.
- Inadequate or slow communications.
- Low morale.
- Costs out of proportion to productivity.
- Low productivity.

11.3.2 The faults in organization usually take the following shape.

- Inadequate delegation (particularly of authority).
- Bad distribution of work.
- Too much specialization of work (or not enough).
- Inappropriate span of control (too narrow or too wide).
- Imprecise definition of responsibilities and authority.
- Too many levels of management.
- Incorrect Job Definitions.
- Improper recruitment.
- Frustration of talent.
- Over staffing leading to under employment.

11.4 Job evaluation: To overcome these problems a Job Evaluation exercise should be carried out. The main aim is to reorganize and re-energize an existing structure, in order to achieve the goals that it purports to be set up for. This evaluation leads to use for the following major applications.

11.4.1 Basic:

- Selecting and engaging staff.
- Transferring employees between Departments,
- Promoting Staff.
- Setting up Training Schemes.
- Pay roll work.
- Cost estimating.
- Budgetary work.
- Compiling salary scales.

11.4.2 Primary;

- Dynamizing/ Re-energizing Organizations.
- Preparing Organizational Charts.

- Reduction of dead weight.
- Increasing efficiency.
- Improving Input/ Output Ratio.
- Fixing responsibilities.
- Removing Bottlenecks.
- Preparing Work flow Charts.
- Proper delegation of authority.
- Promotion of coordination.
- Promotion of efficient communications.
- Raising productivity.
- Correct distribution of workload.
- Provision of job related facilities.
- Evaluating aids and machinery used.
- Evaluating additional aids and machinery required.
- Evaluating procedures.
- Evaluating techniques.
- Providing increase in Management Information
- Services.
- Laying basis for computerization.

11.5 Methodology: The manner in which a Job Evaluation exercise is carried out is:

- Familiarization Tour.
- General survey and examination of organizational-Documents.
- Estimate of time effort and cost.
- Circulation of materials to acquaint employees with reasons and methods of the exercise.
- Preparation of team; program and strategy.
- Personal observation and interviews to determine existing Job Descriptions and specifications (Annex A).
- Completion of Job Definition for Evaluation (Annex B).
- Build up composite of work; time; procedure and technique analysis.
- Evaluation of existing structure against the goals of the Organization, keeping in mind finances involved.
- Restructuring of Organization within the framework of finances available.
- Practical application and dove tailing.
- Evaluation of results.
- Effecting changes if and where required.
- Submission of detailed report and lessons learnt for future application if any.

11.6 FOLLOW-UP: Once the basic work is accomplished, follow up is carried out for:

11.6.1 Equipment: Keeping in mind the information brought to light by the Evaluation exercise, a complete review of equipment required as against equipment held and its condition is undertaken. The aim of this review is to check efficiency and increase effectiveness. Recommendations are made as to the advisability of further induction of equipment. This process is necessarily part and parcel of the Evaluation exercise.

11.6.2 Computerization: With the results of the Evaluation exercise, a program of computerization is chalked out. Recommendations are made and efforts are carried out to complete this phase with minimum possible costs to achieve maximum efficiency.

11.6.3 Training: Many of our experts have received training at Government expense. A Talent Pool should be formed and Training Institutes be set up, in order to disseminate information to others. Training should be compulsory for promotion and this policy should be vigorously enforced. It is only with up to date training that our personnel will be able to gain new insights and motivation to do their jobs properly. Training programs grow out of the Evaluation exercise, and should be established on a crash course basis and gradually allowed to settle down into routine.

11.6.4 Public Access: The Public has the right of access to the inner working and achievements or otherwise of Government Organizations. The Evaluation exercise should and must recommend areas where this right can be enforced. This is primarily to introduce an element of accountability and force the Organizations to be more sensitive to the requirements of all citizens. Secondly procedures should be simplified and forms be introduced or redesigned where already existing.

11.7 Conclusion: It is imperative that we bear in mind that this exercise is essential to our very survival and wellbeing. If the exercise has already been carried out in some Organizations, a review of effectiveness or implementation be carried out. Any further requirements be pointed out and effected. The opportunity exists to right the wrongs of the past and ensure that malpractices are avoided in the future. The role of Nation Building, though demanding and difficult, is essentially the most important aspect of our daily lives. The person or persons involved in getting things to move along positive lines renders the greatest service to his fellow man and is long remembered as the builder of his time. It is strongly recommended that the suggestions outlined should be examined critically but dispassionately and if found acceptable, undertaken without loss of time.

Figure 7: Job Analysis:

Ref. No.	JOB DESCRIPTION		Date: / /
Job Title:			Pay Scale:
Branch:		Department:	
Reports to:		Working Hours:	
Responsible For:			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Duties:		Tasks:	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
Skills:			
1			
2			
3			
4			
5			
Knowledge:			
1			
2			
3			
4			
5			
Education:		Training:	

1		1	
2		2	
3		3	
4		4	
5		5	
Education Required:		Training Required:	
1		1	
2		2	
3		3	
4		4	
5		5	
Promotion:		Scale:	
Prepared By:		For:	

Figure 8: Job Evaluation.

JOB DEFINITION FOR JOB DESCRIPTION:

Ref. No.		Date: / /
Job Title:		Pay Scale:
Branch:	Department:	
Reports To:	Working Hours:	
MAIN PURPOSE & JOB SUMMARY:		
JOB CONTENT: IMPORTANT ACTIVITIES:		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
TIME ACCOUNT:		
1		
2		
3		
4		
5		
6		
EFFORT ACCOUNT:		
1		
2		
3		
4		

5	
6	
PRINCIPAL SKILLS REQUIREMENT:	
1	
2	
3	
4	
5	
6	
PRINCIPAL RESPONSIBILITIES:	
1	
2	
3	
4	
5	
6	
Education Required:	
Decision Making:	
ANALYSIS:	
WORK:	
Monotony:	
Physical:	
Field Work:	
Team Work:	
Environment:	
Hazards:	
Miscellaneous:	

Collector:	Prepared By:
For:	Signature:

12 Management Audit:

Over the years and in some instances as long as one hundred years ago, efforts have been made towards planning. These reports, plans and studies cover a host of topics and are to be found in various offices all over the Country. Most of these reports, etc. have not seen the light of the day. To avoid duplication, and sometimes to add information, it is necessary to gather together as

many of these reports, etc. as possible. In the case of District Governments these will be found at three layers, the District, the Provincial and the Federal. More importantly there exist a number of assets that belong to various Departments. At present these are scattered around the area in a completely random manner. Offices and residences are being hired at places convenient to the hiring authorities and in complete disregard to public convenience or even discharge of its own functions. At the same time much public property is lying unutilized. Many "Shamilat Deh" lands (common village property) have been encroached upon. Thus it is evident that the intellectual and physical assets of the District Departments should be managed and used in an optimum manner. The establishment of an Assets Management Cell under the District: "Zilla Council Committee" would greatly facilitate this objective. O&M functions could be relegated to the record of this Cell. The Land Record Reform as outlined above would also find a niche within this Cell. Freedom of Information and regular handouts regarding Finances and changes would lead to a more transparent regime. Rationalization and utilization of assets would lead to an increase in efficiency and accountability. There is a dire need for consolidation of offices in order to promote accessibility and control. Owned property and associated reduction in overheads in the shape of rents is to be preferred. There exists a strong possibility of carrying out just such an exercise in Abbottabad District.

13 Reorganization & Re-equipment:

Based upon overall assessment of the preceding primary data, there is a need for reorganizing structures and providing them with the technical tools to enable them to get their jobs done. This, of course, case and means dependent. In most cases it will be possible to arrange the requisite funds and equipment for the task of implementing a Sustainable Development Action Plan/ District Conservation Strategy.

14 Monitoring & Evaluation:

14.6 It is important to be able to assess human and ecosystem conditions, evaluate them and develop plans to make these conditions sustainable. The projects and programs that are developed to achieve this end need careful and close analysis to provide us with the feed back required to fine tune or focus our efforts. Finally institutional analysis is required for the controllers and users of Sustainable Development Action Plans. The IUCN has developed these three types of assessment and have termed them as:

- System Assessment: Assessment of human and ecological systems and their interactions.
    - *Participatory and Reflective Analytical mapping (PRAM):* This method helps planners, field workers and researchers to reflect on a system from an early stage and identify priority areas for action.
    - *Assessing and Planning Rural Sustainability:* field teams and rural communities working together use This. The first stage is assessing rural sustainability y and the second is planning action for rural sustainability.
    - *System Analysis and Planning:* This is a method of assessing human and ecosystem wellbeing and institutional strengths and limitations. It includes identification of priorities and options, design of development strategies and

action plans and formulation of an implementation and monitoring framework.

- Project Assessment: Assessment of the conduct or results of a project or set of activities.
  - *Legal Framework Analysis (LFA):* Method of project monitoring and evaluation for use within the planning framework of reflective organizations.
- Self-Assessment: Internal assessment by an organization or group.
  - *Systematic Analysis of Experience (SANE):* Framework to recover institutional memory and learning through a process of retrieval, analysis and documentation of past experiences of organizations and projects.
  - *Development of Reflective Capacity:* This method helps an organization to develop a capacity for reflection by clarifying its mission, analyzing what makes an institution reflective and then restructuring it accordingly.
  - *Institutional Implementation Capacity Assessment:* To help organizations to evaluate their capacity to carry out their mission and projects.

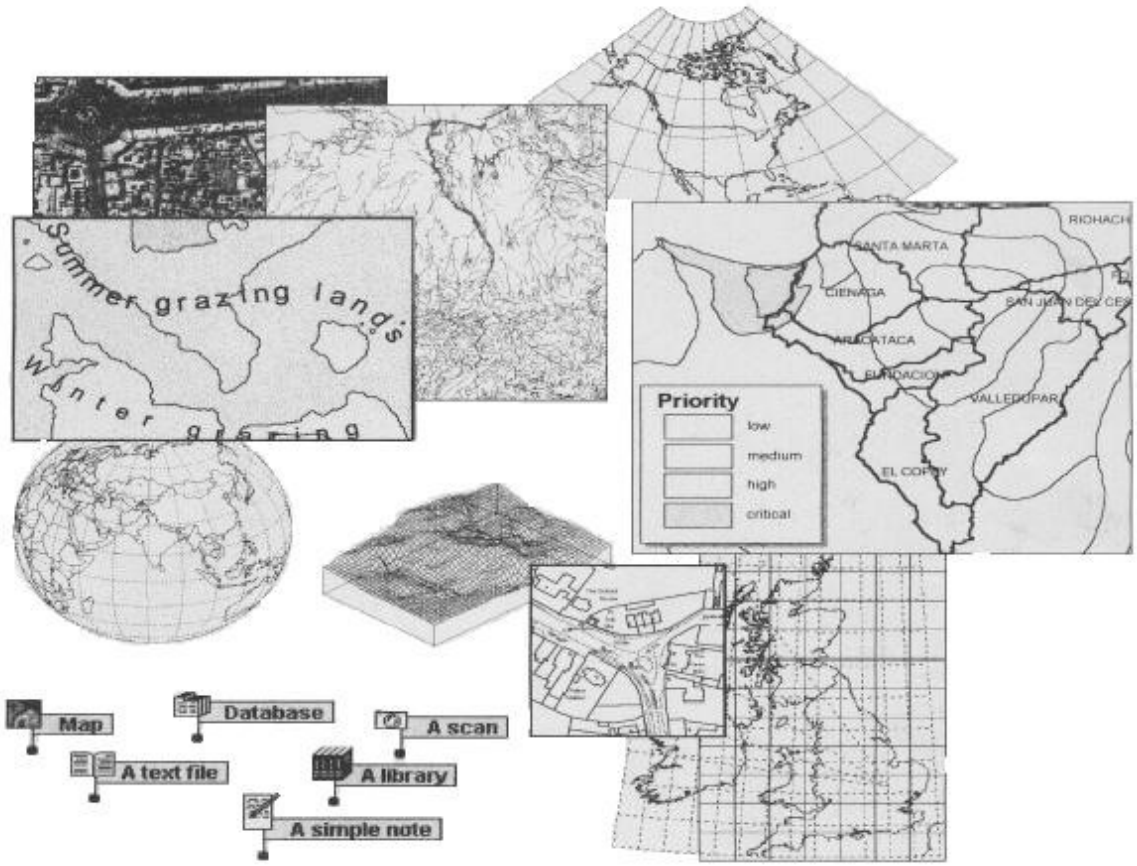
14.7 Assessing progress towards sustainability has two key features:

- People and ecosystems are treated as equally important. People are integral to ecosystems. Thus sustainable development entails improving and maintaining them both.
- Fostering questioning. Indicators and other tools that help us can only be found if we know what questions we are trying to answer.

14.8 By now we have gathered plenty of primary data to serve as benchmark or baseline data for assessment. There is a need for collation and interpretation of this data to serve as a Situation Analysis against which the Sustainable Development Action Plan can be prepared. There are several tools which can be used for this purpose:

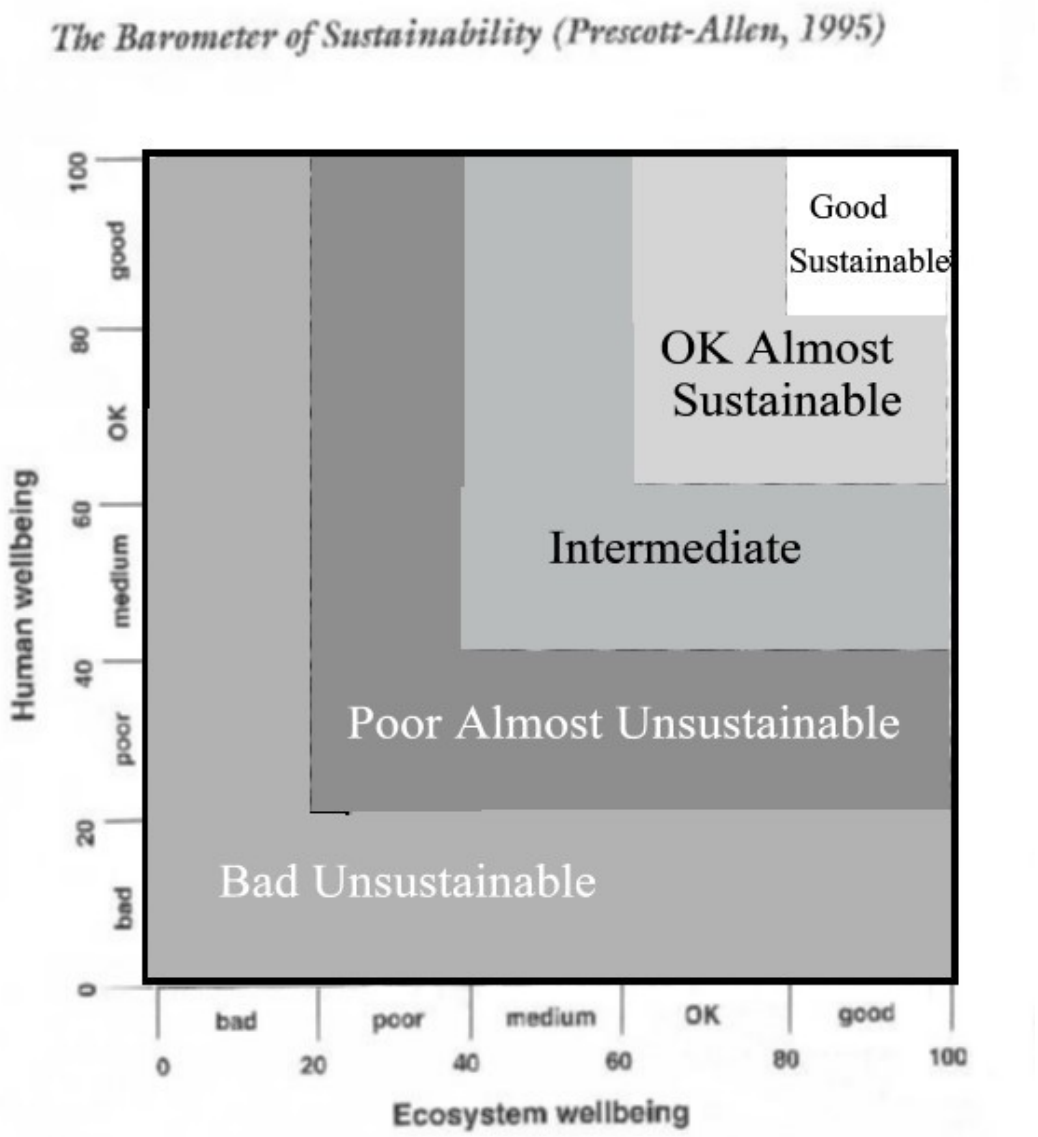
- Most of this data can be depicted graphically on various layers of a map. Geographical Information Systems (GIS) like MapMaker Pro have powerful data analysis ability and are word processor and database compatible. Numerical data obtained from Field Surveys can be fed directly into the program to generate maps where no base maps are available. The calibrations required to make simple, virtually zero-cost survey instruments, using the printer as a manufacturing tool, are built into the program. Map Maker Pro builds up maps from data stored in a system of layers. The user can select a theme for each layer: roads, water supply; drainage; demographic details etc. to be superimposed at will, in any combination, onto the base layer.

Figure 9: MapMaker Pro.



- Barometer of Sustainability: For measuring and combining indicators of human and ecosystem wellbeing and progress towards sustainability. It is a performance scale designed to measure human and ecosystem wellbeing together without submerging one in the other. Its key features are:
  - Two axes, one for human wellbeing and the other for ecosystem wellbeing. This enables each set of indicators to be combined independently, keeping them separate to allow analysis of people-ecosystem interactions.
  - The axis with the lower score overrides the other axis. This prevents a high score for human wellbeing from offsetting a low score for ecosystem wellbeing (or vice versa) – reflecting the view that people and the ecosystem are equally important and that sustainable development must improve and maintain the wellbeing of both.
  - Each axis is divided into five bands. This allows users to define not just the end points of the scale but intermediate points as well, for greater flexibility and control of the scale.

Figure 10: Barometer of Sustainability.



- Six-Stage cycle: Each assessment follows a cycle of six stages:
  - From overview to indicators – the first four stages, which determine what and how the assessment will measure and then take the measurements.
  - From indicators to overview – the last two stages, which combine the measurements, analyze the results and translate them into conclusions for action.

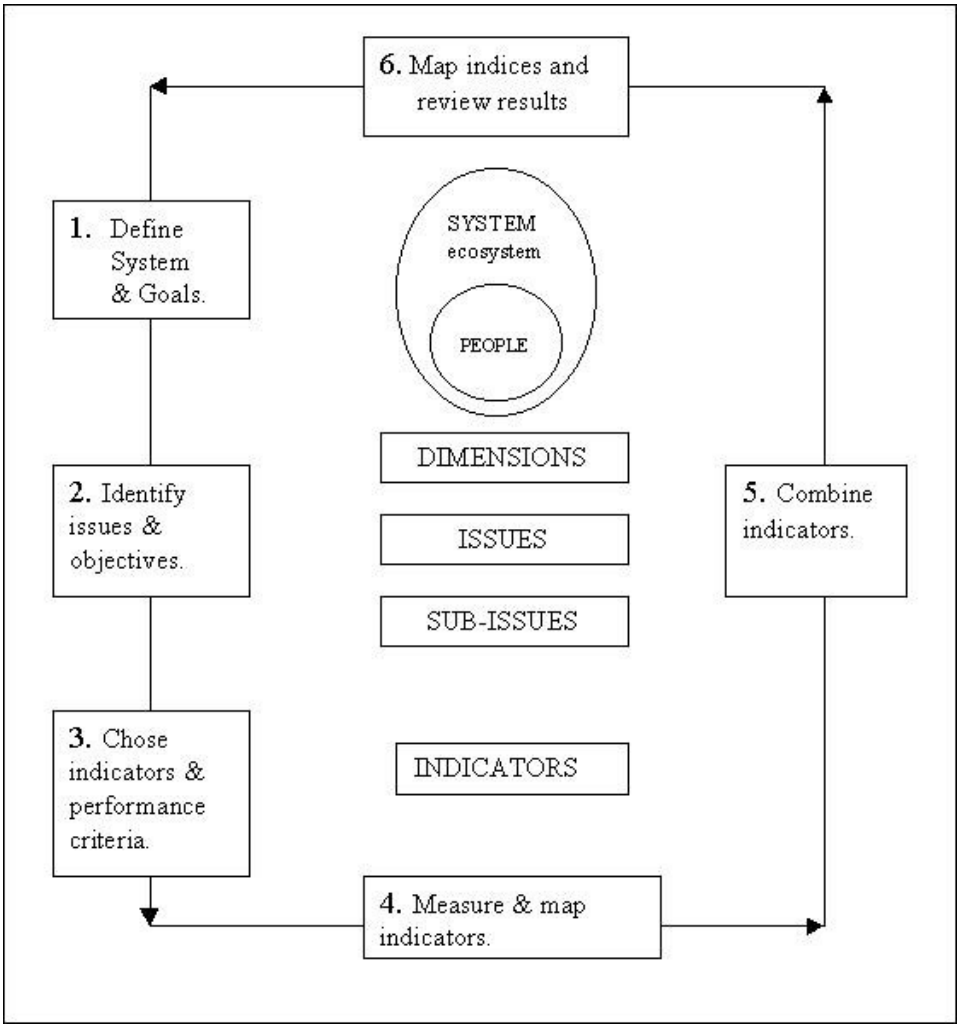


Figure 11: Six-Stage Cycle.

- Program to score and link data generated by the Barometer with MapMaker.
- Indicators: These are essential and common to all assessment methods. Community-based indicators are a description of how to help communities to develop their own indicators.

14.9 User-driven process[2]: The users of an assessment are decision-makers and the people who influence them, at the level of the assessment: for example, villagers in a village assessment or District leaders and constituencies in a District assessment. The crucial assessment decisions are to identify the issues and objectives, chose the indicators, and decide the performance criteria. The users make these decisions. The users are likely to be assisted by a technical support team

[2] Assessing Progress Toward Sustainability: Workshop on System Assessment Method. IUCN-1999

that would compile and manage data, combine indicators into indices, map the indicators and indices, analyze the results, and draft texts. But the users-the people expected to use the results of the assessment to decide policies and take actions-are the ones to make the main assessment decisions. Participation in the process of an assessment is more likely to influence decisions and actions than simply reading the results of someone else's assessment. Therefore, there should be an inclusive, open approach to participation, giving anyone who wishes the opportunity to contribute constructively. In addition, the data used in the assessment need to be made available to all, and assumptions and judgements clearly stated so that others may test alternate interpretations.

14.10 Without these key features: Assessments can degenerate into mere compilations of data from which it is hard to draw useful conclusions-all mess and no message. At best, the assessment's investment of money, time and effort will not return full value in useful information for decision-making.

14.11 With these key features: Assessment can show:

- Condition and trend of people.
- Condition and trend of the ecosystem.
- Overall wellbeing.
- Progress towards sustainable development.
- Condition and trend of major components (health, economy, land, species diversity, etc.).
- Issues where performance is weakest (or strongest).
- Key relationships, such as benefits from resource sectors per unit of ecosystem stress.
- Priority information gaps.

15. Conclusion:

Effort has been expended on the paper due to the fact that as Manager Abbottabad Conservation Strategy I am not convinced that the laid out process has provided meaningful data nor has it made full use of participation. As such it is felt that the exercise is not yet capable of producing the requisite Strategy Document that would be a meaningful and implementable Strategic Action Plan for Sustainable Development.

CONCLUSION:

The entire fore going document is an attempt to bring clarity and detail to an otherwise foggy situation. Uncertainty and lack of direction, even after over 50 years of existence, is just not acceptable. The fast pace of degradation, burgeoning populations and spiraling cost of living are all contributing to a chaotic and non-sustainable situation. The capabilities that are inherent within the local populous and local resources are quite adequate to take up the challenge. With external support and technical assistance a well directed effort towards sustainability could be launched. This would have far-reaching and extremely positive consequences. It is pertinent to bring out one very vital lesson that has been learnt by the compiler of the report, in the field. In 1999 an attempt was made to bring the impact of demonstrated rural development to the deprived poor, in a dynamic manner. The place chosen for intervention was in Daharki, District Ghothki, Sindh Province. Dacoity and abduction for ransom was rampant in the area and inter provincial animosity was very much in evidence. By chance, the place chosen for establishing a small demonstration project was surrounded by three families, each belonging to a different Province and race. Baluchies to the South, Pathans to the West and Sindhis to the North. The Khidmat Foundation team, consisting of Punjabi workers, arrived to establish camp right in the middle of this grouping. Despite concern and warnings from all sides, work proceeded apace. The efforts had hardly come on ground when it was noticed that a spirit of cooperation and hope was emanating from the area. Sharing of meals between the four racial groups was an everyday feature. People were not spectators but were eager to participate in what appeared to be a production revolution. The plans of the Foundation were eagerly discussed and awaited. It was realized that it was economic pressure that was creating rivalry and a sense of insecurity. Hope and vision of plenty soon caused the bitter clouds of prejudice to dissipate. People are basically good and competent. It is only when nepotism and injustice along with incompetence and short sightedness prevails that the inherent potential of peace and goodwill is eroded and subsumed in an atmosphere of ill will and fierce material, no holds barred competition. In order to be able to follow a better path, it has to be shown and clearly marked. To feel threatened by others capabilities only reveals personal shortcomings. The common good is a transcendental objective that is the raison-detre of life on earth. The theme of a living Universe that is above and beyond our petty imaginations is very much true. To contribute, however humbly, to such an objective is the highest aspiration that a human being can attain. It is our solemn duty to dedicate every effort towards achieving Sustainable Development, Peace on Earth and Goodwill to all. This is more than a catch phrase, it is a necessity. Future generations depend upon rational decisions that are urgently required. We hold the means of both ultimate destruction and prosperity within our grasp, what will we choose?

FOR THE CAUSE THAT LACKS ASSISTANCE!
FOR THE WRONG THAT NEEDS RESISTANCE!
AND FOR THE GOOD THAT WE CAN DO!

Created by: Sardar Taimur Hyat-Khan.

CROP PESTS & DISEASES IN ABBOTTABAD DISTRICT:

Chemically unstable and inappropriate fertilizer regimes as well as poor cultural practices have led to an ever increasing array of pests and diseases in most crops in the District. Excessive Nitrate Nitrogen leads to the plants sucking of calcium from its cell walls in order to assimilate the Nitrates and convert them into Amine form. This results in leaking of nutrients, resulting in what is termed as a "Chemical Taxi" or "Chemitaxi". Crawling insects in search of food hit upon this trail and follow it directly into the plant. Flying insects are attracted by the scent of excessive amino acids in the leaves used to convert the Nitrates. Excessive Nitrates are directly caused by unstable Urea hydrolysis and volatilization. The Nitrogen content of DAP is also quickly converted into Nitrate form. When this is compounded by lack of crop rotation to break pest cycles and poor cultural practices pests and diseases are bound to flourish.

1 Some of the pests and diseases that are common in fruit such as Apples; Apricots; Almonds; Peaches; Plums in the District are:

1.1 Insects:

- Coddling Moth.

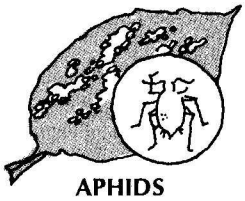
This is a serious pest of fruit; the coddling moth spends the winter as a full-grown larva about ¾ inches long in a partial cocoon under flakes of bark. The larva changes to the brown pupa stage in spring and emerges as a moth during the latter part of May and throughout June. The adult moth is slightly over ½ inches long and has a dark, chocolate-colored band along the base of the wing. The moths fly late in the evening and deposit eggs singly on the foliage and fruit. Fumigants and Contact type insecticides are used but do not provide complete control. Sometimes larvae can enter the fruit before they die and cause injury. Natural oil sprays are also effective in May and June when they deny oxygen to emerging larvae.

- Scale.

The San Jose scale is a small, soft-bodied insect that secretes a hard, protective; terrapin-like covering which is resistant to insecticides. This small, circular scale is about the size of a pin head. It is usually dark brown to black and has a raised, dull yellow, nipple-like center. The overall appearance during winter is an ashy-black condition on the bark. Control is afforded by a dormant or delayed dormant oil spray mixed with an active ingredient. Contact type insecticides may be used in June when young scale nymphs (crawlers) are migrating over the plant. Migration lasts about one week before the small crawlers insert their mouthparts into the plant tissue and take up permanent residence. The hard scale covering is secreted soon after and the insect is no longer susceptible to the usual summer insecticides.

- Nocturnal Beetles.

- Aphids.



APHIDS

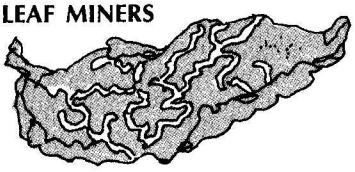
These can be green, black, yellow, or pink. Hose off with water or soap solution. Use rotenone, malathion, ryania, pyrethrum or sevin.

Aphids are the most serious of sucking pests and can be identified as small, soft-bodied insects, usually identified by two small cornicles (horns) on the end of the abdomen. They usually feed in groups; winged and wingless individuals are usually present in the same colony. Natural predators like ladybird beetles feed on aphid colonies both as adult beetles and immature larvae. Where pesticide sprays are unavoidable, pre-bloom sprays are usually most effective.

- Leaf Miner.

If borers eat into leaves and fruit . . .

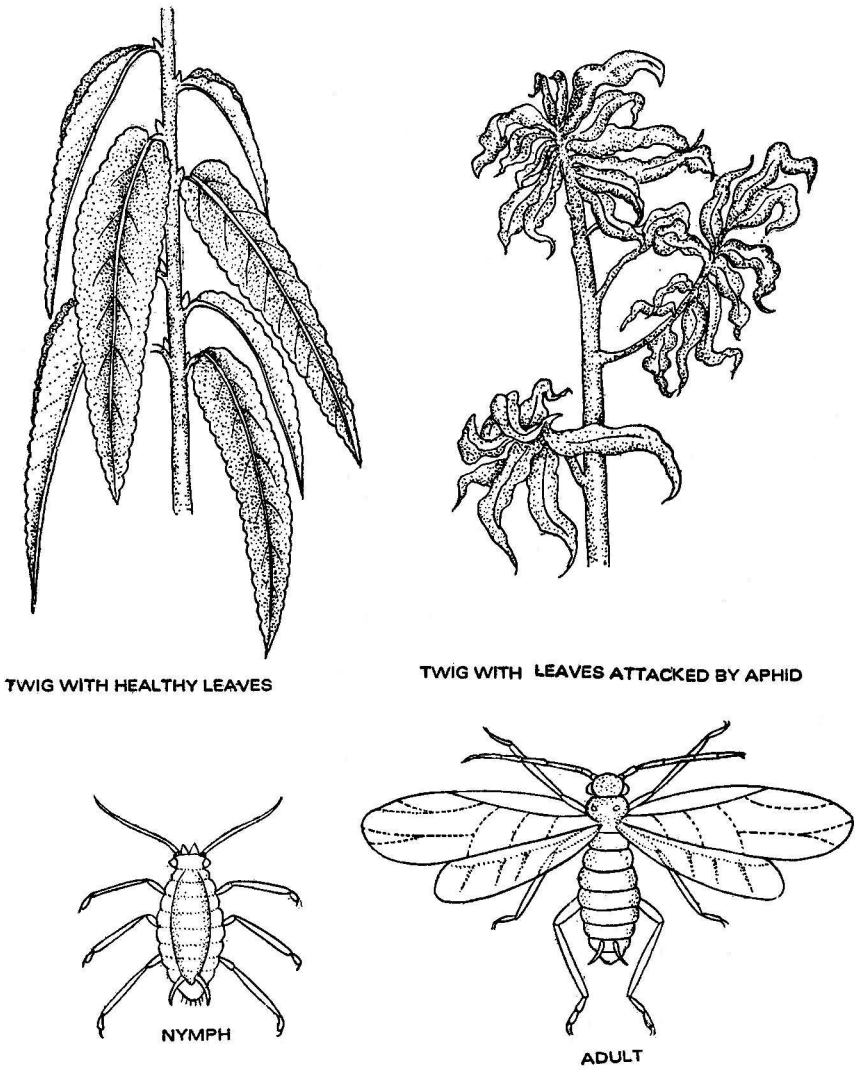
LEAF MINERS



Insects lay eggs on leaf surface. Larvae enter leaves; feeding results in a serpentine trail. Pick off infested leaves. Use rotenone.

- Stem Borer.

- Fruit Fly.



Peach leaf-curl aphid.

PEACH FRUIT-FLY[1]

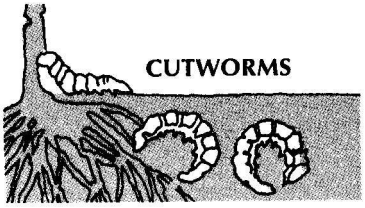
- White Ants.

1.2 Diseases:

- Powdery Mildew.
- Apple Scab
  - Leaves.
  - Fruit.
- Stem Rust.
- Root Rot.
- Gumosis (Apples and Pears excepted).

1.3 Other pests and diseases that afflict various fruit are:

- Guava: Fruit Fly.
- Walnut: Borer: Fruit and Stem.
- Persimmon: Leaf Roller and Stem Borer.
- Strawberry: Cutworm Complex.



These moth caterpillars cut off stems at ground level or eat leaves. Use a tarpaper collar. Use sevin or diazinon.

2 The pests and diseases of vegetables are:

2.1 Winter Vegetables:

- Cauliflower; Cabbage; Turnip; Radish; Peas and spinach. These are attacked by Cabbage butterfly; Cut worms; Fruit borers; Aphids and Armyworms.

2.2 Summer Vegetables:

- Potatoes:
  - Pests:
    - Cut worms.
    - Stem Borers.
    - Army Worms.
  - Diseases:
    - Early Blight.
    - Late Blight.
    - Scab Viruses.
    - Fruit Rot.
- Tomatoes:
  - Pests.
    - Cut Worms.
    - Fruit Borers.
  - Diseases.

        - Ring Rot.
    - LadyFingers.
        - Pests.
            - Fruit Borer.
        - Diseases.
            - Powdery Mildew.
    - Chilies.
        - Pests.
            - Cut Worm.
        - Diseases.
            - Ring Rot.
    - Gourds.
        - Pests.
            - Cut Worms.
            - Fruit Flies.
    - Cucumbers.
        - Pests.
            - Cut Worms.
            - Fruit Flies.
        - Diseases.
            - White Rust.
    - Brinjal.
        - Pests.
            - Cut Worm.
            - Fruit Borer.

3 The pests and diseases common in field crops are:

3.1 Maize:

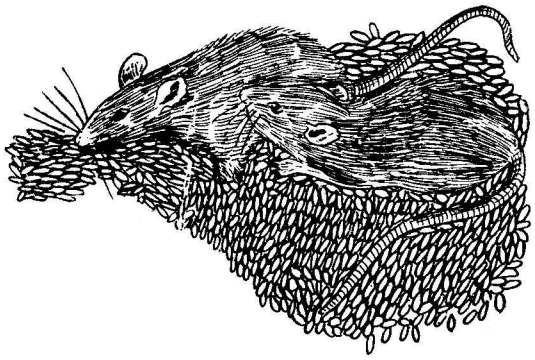
- Pests.
    - Cut Worms.
    - Stem Borer.
    - Top Borer.
    - Army Worm.
    - Aphids.
- Diseases.
    - Canker.
    - Smut.

3.2 Wheat:

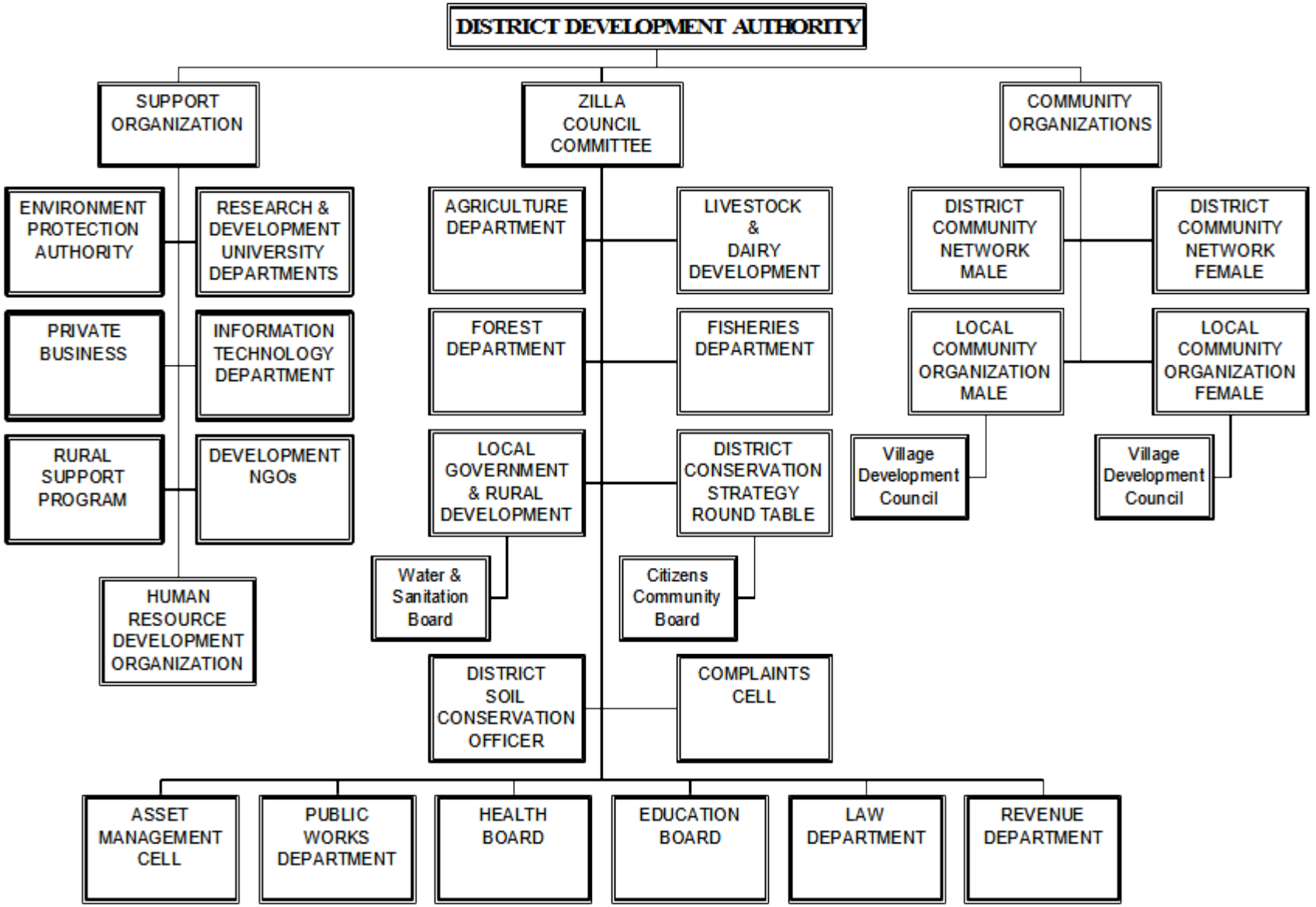
- Pests.
    - Army Worm.
- Diseases.
    - Loose Smut.
    - Yellow Scab.

4 Hidden Problem: A serious problem that is often overlooked is that of rodents and porcupines and flying squirrels. The Indian Mole Rat (*Bandicota bengalensis*)

hides in the sides of channels and eats roots and fruit, attacks maize, rice and wheat. The Picus is a hilly snow rat and eats the barks of fruit trees. The flying squirrel gnaws upon walnuts, other fruit trees and pine shoots. The Indian crested porcupine (*Hystrix indica*) attacks orchards and tuberous crops. The store rodent *Ratus ratus* is a serious store pest.

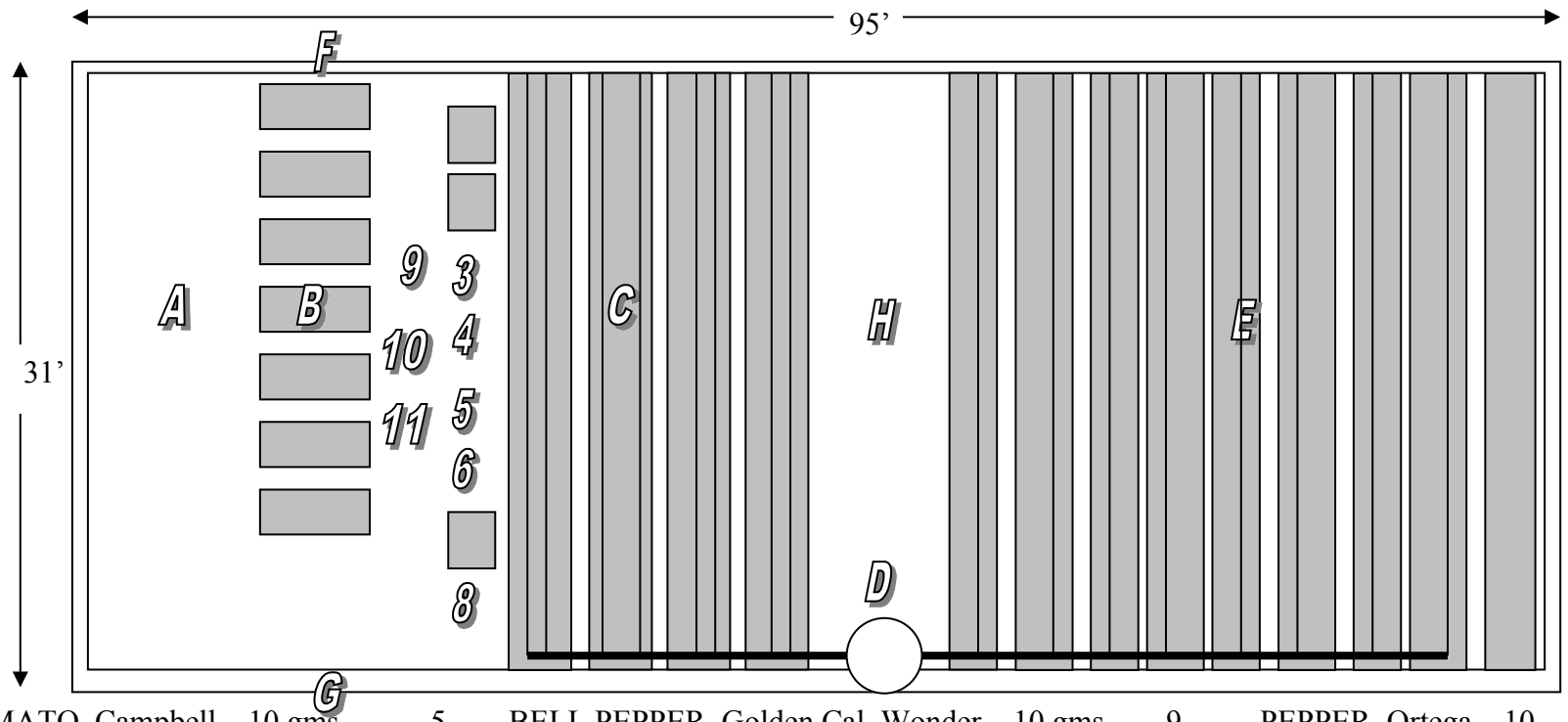


PROPOSED STRUCTURE:



Annex 1: District Development Authority:

NRCP Nursery: Kala Pull, Abbottabad. Conservation Irrigation, Permaculture Intensive Vegetable Demonstration Plot: 03 – 03 –2001



1. TOMATO, Campbell – 10 gms.
2. TOMATO, Roma VF – 10 gms.
3. TOMATO, ACE—55 – 10 gms.
4. BELL PEPPER, Jupiter – 10 gms.
5. BELL PEPPER, Golden Cal. Wonder – 10 gms.
6. BELL PEPPER, Capistrano – 10 gms.
7. BELL PEPPER, Taurus – 10 gms.
8. BELL PEPPER, Emerald Giant – 10 gms.
9. PEPPER, Ortega – 10 gms.
10. PEPPER, Ghothki – 10 gms.
11. PEPPER, Bograzi – 10 gms.

A: Bed – 14 ft. x 31 ft.
B. Beds 8 ft. x 2 ft. Mino variety Radish.
C. Beds 3 ft. x 30 ft. Double Drip.
D. Stand for raised Water Drum.
E. Beds 2 ft. x 30 ft. Single Drip.
F. Upper Drainage.
G. Lower Drainage.
H. Walkway.
PLOT: 31 ft. x 95 ft.

1. The Field Project Manager of NRCP has been extending considerable support to the Project Manager IUCN – ACS Support Unit. As a matter of advice the PM ACS is encouraging Organic farming and 21st Century Nutrients for Horticulture to replace the outdated and harmful mineral nutrient, conventional agriculture that is in vogue. The current practices have left the small landholdings of Abbottabad bereft of nutrients and provide a meager source of income to the farmers. Whereas it is possible to engage in rational horticulture to increase returns manifold as well as provide protection to the fields and build up fertility levels. This is a minimum 5 year prescription if costs are to be curtailed. Thus a gradual shift from conventional to rational and sustainable culture is prescribed. In order to achieve this target a number of initiatives have been taken, such as:

1.1 Quick Composting through Effective Microbial (EM) Technology.

1.2 Low Cost, Environment Protected, Compost Bed, Sub-Soil Irrigated, Companion Herb & Vegetable Kitchen Garden.

1.3 Use of Certified and Standard Vegetable Seed through North South Seed Company.

1.4 Use of 21st Century Liquid Nutrients (Major, Secondary and Micronutrients) and Natural Rooting & Fruiting Hormones through Stoller Pakistan (Pvt.) Ltd.

2. To further this effort, in order to help it to take root in Abbottabad District, The FPM, NRCP has offered to use of a plot of land in the NRCP Nursery situated near Kala Pull, Murree Road, Abbottabad. The plot measures 95 ft. by 31 ft. and is situated in the middle of a tree nursery established by the NRCP. A low-cost Drip system has been provided as a sample by ICIMOD of Nepal along with sharing of Water Harvesting Technology. Together all of the above represent a package of soft technology that can be treated as a survival package to supplement the incomes of the rural poor and also introduce the benefits of Conservation and Environment Protection through recycling. The very process is a method of introducing the requisite skills and mode of thinking that is Eco-friendly and wholly consistent with sustainable development.

3. As the actual planting of the plot was done on the 3rd of March 2001 there was very little time to prepare the land in a manner suited to Permaculture. The advanced season also precludes commercial level production of many vegetables. However, since the ACS was in possession of a number of seed packets sent by North South Seeds, it was deemed necessary to take the plunge and start the arduous journey towards demonstrating self-reliance to the inhabitants of Abbottabad District. The ACS is in the process of formulating a Sustainable Development Action Plan for the District of Abbottabad called the Abbottabad Conservation Strategy. While the main emphasis is upon Strategy Formulation, never the less, it is deemed proper to support the Strategy Formulation effort with minor on-ground efforts. This is deemed necessary for the following reasons:

3.1 Seeing is believing.

3.2 Practical measures promote ownership.

3.3 While the technology is simple it is none the less new to the area and can be explained/ communicated by actually doing it.

3.4 Costs support will be borne entirely by the NRCP whose principle job is to implement the Natural Resource Conservation Project (NRCP) as is evident by its name.

3.5 The NRCP is also an effort of the IUCN, The World Conservation Union, and as such deserves the full cooperation and support of all IUCN employees as well as friends of the earth.

3.6 The present economic activities of the people of Abbottabad are not sustainable and the course towards sustainability has to be charted.

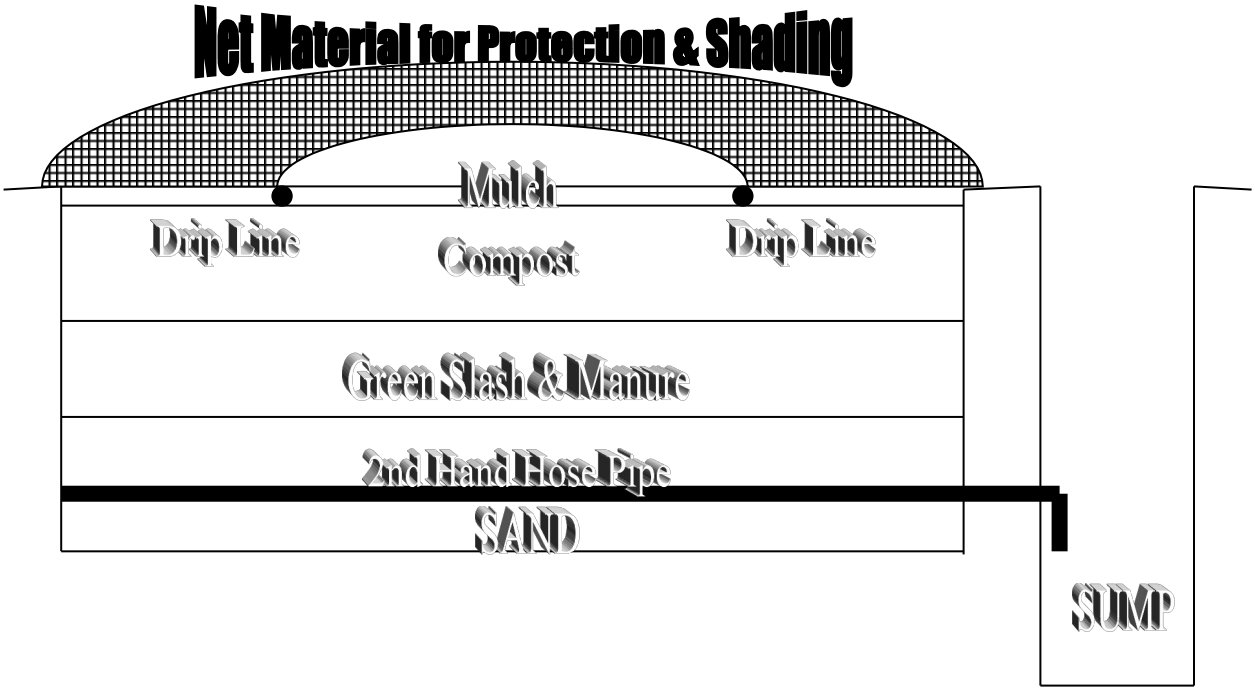
3.7 Concepts brought forth in the Sector Paper on Agriculture & Horticulture can be demonstrated for effect and debated on ground before being permanently incorporated in the Strategy Document.

4. In light of the above the plot of land, hereinafter referred to as Pak Beds, were worked over and 11 small plots (3.5 x 2.5 ft.) of seedling nurseries were planted with 3 varieties of Tomatoes, 5 varieties of Bell Peppers and 3 varieties of Peppers, 10 grams each. Additionally 7 beds of 8 x 3 ft were planted with Mino variety of Radish (30 gms.).

5. The soil in the present Pak Beds consists of badly drained heavy Clay Loam. In order to get the planting done; some available sand was mixed into the prepared beds. The present staff has been instructed to carry out watering on a twice daily basis in order to ensure germination. In order to achieve success and make an impact as a meaningful demonstration the following is recommended for adoption. At present the Eid Holidays preclude physical labor. Secondly, approval is sought for the recommendations.

6. Preparation of a variation in the Pakistani, Permanent, Sunken Bed with Reticulation (Sub-Soil Irrigation) as a No-Till Bed is advanced for consideration. Due to the nature of the soil (poor drainage) and the prevalent physical and weather conditions, these variations are necessary for success.

6.1 The Beds:



This particular variation of the Pak Bed will afford the most suitable environment to the plants and is recommended for the portion of the Rash Plain in which they are situated. There is no purpose in demonstrating something that is not sustainable and does not provide the micro environment required by the plants. As the area is subject to hail storms in the early summer and is also open to chicken and bird pest, additional protection in the shape of netting is also recommended. This would preclude loss and

damage and ensure success of the demonstration. The net material can be purchased 2nd Hand and support can be fabricated from twigs of Eucalyptus or Popular Trees.

6.2 Plant Nutrition: In order to reap the maximum benefit from planting it is necessary to provide the plants with complete nutrition. Firstly a complete NPK formulation is required. This can be met by the following:

i. Ammonium Sulfate (21 % N + 24 % S, pH 4).
ii. Triple Super Phosphate (46 % P + 14 % C, pH 4).
iii. Sulfate of Potash (50 % K + 18 % S).

These Commercial, mineral fertilizers are available in Haripur (Dingi Tubewell), unfortunately our immediate requirement does not cover one bag each. In case it is advisable to formulate NPK fertilizer and repack in smaller bags for provision to farmers along with seed packets provided through ACS to NRCP, this problem can be overcome. This would be a great and trend setting service to the farmers. The requirement put briefly is due to the following. Nitrogen is responsible for overall growth; phosphorus for root, fruit and seed development and potassium for plant protection. Specific Plant requirement ratios on Clay Loams as Kgs. per acre are:

i. Radish: 20:40:40.
ii. Pepper/ Bell Pepper: 25:50:25.
iii. Tomato: 30:40:30

Two bags of AS and one bag each of TSP and SOP would provide the following in Kgs.

i. N 21.0
ii. P 23.0
iii. K 25.0
iv. S 33.0
v. C 7.0

For the size of the plot a rough guide would be:

i. AS 6.0 Kgs. (1260 gms. N + 1500 gms. S).
ii. TSP 3.0 Kgs. (1380 gms. P + 420 gms. C).
iii. SOP 3.0 Kgs. (1500 gms. K + 540 gms. S).

6.3 21st Century Liquid Nutrients: It is advised not to put too many new concepts into single demonstrations. However, for the record the following is put up for consideration as additional requirements for more quality, more quantity and more healthy produce:

i. Rooting & Fruiting Hormones: For drought resistance and full genetic potential fruiting: 2 mL per Kg. seed at Rs. 2,500.00 per L.
ii. Calcium & Boron: For flower and fruit retention: 10 mL per L water, foliar application every 10-15 days beginning at 4 leaf stage. Use 250 L water per acre (One 15 L spray tank for the Pak Beds). For five applications this comes to 750 mL CaB. At a rate of Rs. 140.00 per L.
iii. ReZIST (hormones for disease control). With the first application of CaB add 5 mL ReZIST per L water. This comes to 75 mL ReZIST at Rs. 1,200.00 per L.
iv. Nitro Balancer: At flowering stage to ensure uniform flowering. Use 5 mL per L water at weekly intervals for 3 weeks. This comes to 225 mL Nitro Balancer at Rs. 2,000.00 per L.

This comes to Rs. 2.50 + Rs. 105.00 + Rs. 90.00 + Rs. 450.00 = Rs. 647.00. Unfortunately the Compounds/ Nutrients do not come in open packing.

7. The following North South Seed Company seed packets have been provided to NRCP:

7.1 TOMATO:

i.	Campbell.	5 nos. (10 gms. each).
ii.	Roma VF.	17 nos. (10 gms. each).
iii.	ACE – 55.	17 nos. (10 gms. each).

7.2 BELL PEPPERS:

i.	Emerald Giant.	6 nos. (10 gms. each).
ii.	Golden Cal. Wonder.	2 nos. (10 gms. each).
iii.	Capistrano.	6 nos. (10 gms. each).
iv.	Jupiter.	6 nos. (10 gms. each).
v.	Taurus.	4 nos. (10 gms. each).

7.3 PEPPERS:

i.	Ortega.	13 nos. (10 gms. each).
ii.	Ghothki.	7 nos. (10 gms. each).
iii.	Bograzi.	7 nos. (10 gms. each).

7.4 RADISH:

i.	Pinky.	10 nos. (50 gms. each).
ii.	Mino.	9 nos. (50 gms. each).

GRAND TOTAL: 109 nos. (1850 gms.).

Besides these one packet each of the above, less the radish packets, have been planted in the nursery. Of the Radish seed one packet of Mino variety has been used and about 7 gms. of seed has been planted. At an average rate of Rs. 40.00 per packet this comes to about Rs. 4,360.00 for the packets and Rs. 440.00 for the planted seed plus Rs. 25.00 for the 7 gms. Radish seed. Thus a total of Rs. 4,825.00 worth of seed has been provided to the NRCP. As informed by Mr. Tom Brown of North South Seed, he would appreciate a payment of Rs. 2,000.00 as token. The PM ACS discussed this with the PD, NRCP and it was agreed by him that upon presentation of proper documentation this payment could be made by NRCP as part of goodwill to the Seed Company.

8. In case the recommendations are agreed to, it will be possible for The PM ACS to document the effort and present the findings for inclusion in the Strategy Document. Secondly, training classes can be designed to be carried out by NRCP for the Communities of the Galliyat area as the target group for the project (NRCP). The Demonstration cum study effort can include the following:

8.1 Quick Composting through Effective Microbial (EM) Technology.
8.2 Building Soil Fertility levels the Permaculture/ Organic way.
8.3 Use of safe and balanced mineral fertilizers (NPK).
8.4 Proper Horticulture Cultural practices.
8.2 Low Cost, Environment Protected, Vegetable Gardening.
8.3 Use of Certified and Standard Vegetable Seed through North South Seed Company.
8.4 Use of 21st Century Liquid Nutrients (Major, Secondary and Micronutrients) and Natural Rooting & Fruiting Hormones.
8.5 Low-cost, Low-maintenance, Gravity Flow Drip Irrigation from ICIMOD.
8.6 Low-cost Water Harvesting & Storage from ICIMOD.

9. Conclusion: As a last note it is important to realize that we are dealing with life threatening situations. The above effort is primarily aimed as a Relief Package for Survival and should be treated as such. Our environmental condition demands that we take immediate remedial measures along the lines indicated above in order to ensure survivability of our poor

masses, what to talk of sustainability. The on-going semi drought conditions can easily take a turn for the worse. We should be prepared to meet any situation and provide succor and relief.

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Disclaimer:

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